Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JULY, 1913.

EDITORIAL.

SEEING that many of our readers find it trying—especially in artificial light—to read "KNOWLEDGE" owing to its being printed on art paper, we have decided to make a change. Henceforth a surface which is not highly glazed will be used for the letterpress; but justice will still be done to the illustrations by putting them on the paper which has recently been used for the whole Magazine. Under these circumstances it becomes necessary to point out to our contributors that illustrations which are to be inserted in the body of the text must be line drawings, while those in tint or photographs which are to be reproduced for the plates must be suitable as to size, and those which are to go on the same page should be as similar as possible in character.

We take this opportunity of thanking all those who have been helping us to carry on the Magazine and of asking our readers to make suggestions as to articles, especially when they can indicate where suitable material is to be found. Particularly should we welcome astronomical photographs and drawings which would be suitable for plates, and illustrated descriptions of original work which is of general as well as special interest.

As we have said on previous occasions, we are always ready to hear from our subscribers who have anything to say with regard to the improvement of the Magazine, and also as to what features at present existing might with advantage be emphasised. It is obvious that the larger the circulation the more money there will be to spend on the Magazine, and in conclusion the Editors invite everyone who takes a general interest in the paper to coöperate with them and to do something to make it more useful and more widely known.

XUM

THE FOURTH DIMENSION AND ITS BEARING ON THE CAUSE OF UNIVERSAL GRAVITATION.

By A. G. BLAKE, F.R.A.S.

OUR ideas of the dimensions of a body are very largely derived from the circumstances in which these dimensions may undergo variation. Thus we speak of a piece of paper as being of two dimensions because of the great difficulty of changing its thickness compared with the difficulty of changing its length or breadth.

In "flatland"—a hypothetical region where motion confined to two dimensions only is possible—it is quite conceivable—nay, it is a necessary assumption if we are to allow the possibility of concrete bodies in it—that bodies should have a certain thickness in a third dimension which would be invariable in individual bodies, but not necessarily uniform among different bodies. Thus the sum total thickness of bodies in "flatland" would be fixed and invariable. To the inhabitants, who would be incapable of realising thickness, this would result in the conservation of some physical attribute peculiar to bodies of two-dimensional space.

In seeking evidence of a fourth dimension, then, we must draw our inferences from the conservation of some physical attribute peculiar to three-dimensional space. The most obvious—indeed, the only one—is the Conservation of Mass. We cannot, however, infer that mass is the three-dimensional perception of a four-dimensional thickness; for the mass of a body is directly alterable by changing its three known dimensions by simply cutting or breaking the body. If we change only three dimensions of a four-dimensional body the fourth must remain unchanged. Suppose (L), (B), (T) to be the units of length, breadth, and thickness, (M) the unit of mass and (F) the unit of "fourth dimension."

Then, since mass varies directly as volume,

$$(M) = \mu\,(L), (B), (T), \text{ when } \mu \text{ is some constant.}$$

But since the fourth-dimensional unit is a constant for any one body, and (F) is the unit, we may put

$$(M) = (F), (L), (B), (T).$$

$$\text{Therefore } (F) = \frac{(M)}{(L), (B), (T)} = \mu = \frac{\text{mass}}{\text{volume}}.$$

But $\frac{\text{mass}}{\text{volume}}$ is what we call density.

Accordingly, in our three-dimensional universe every body has a thickness in a fourth dimension, which is variable in different bodies, but invariable in the same body, and that fourth-dimensional thickness is the body's density.

That this fits in perfectly with analogies drawn from two-space is easily shown. Thus in "flatland" we may consider a two-dimensional body with a small thickness in the third dimension. A "flatlander" would cut down its length and its breadth, but would be powerless to alter its thickness, so that its volume would vary as its area. Extending this to three-dimensional space, we may cut down a body in three dimensions—length, breadth, and thickness—but we cannot alter what we may call its fourth or extent in a fourth dimension, so that its mass varies as its volume. In fact, mass in four-space corresponds to volume in three-space and area in two-space. The volume of a three-dimensional body is infinity times as great as the volume of a two-dimensional body. The mass of a four-dimensional body is infinity times as great as the mass of a three-dimensional body (*i.e.*, one whose density is nil).

Though we cannot directly change the extent of a body in its fourth dimension we can do so indirectly by taking advantage of the principle of the conservation of mass and compressing the body in three dimensions. The two-dimensional equivalent to this is that in two-space, though it is impossible directly to alter the third dimension; yet by compressing it in two dimensions the third will be increased, while the volume will remain constant. For in two-space the chief physical principle would be the conservation of volume, though under what aspect volume would present itself to "flatlanders" we can never tell.

Having shown how a body's density may be our perception of its thickness in a fourth dimension, I shall endeavour to explain the cause of Universal Gravitation—why any two bodies in space will attract each other, and why the force of attraction will vary directly as the mass and inversely as the square of the distance separating them.

For the purposes of my theory I assume that matter is surrounded on all sides by an ether of vast extent in every direction—in all four dimensions. I shall show hereafter that the very great density implied in the last clause is not incompatible with absence of gravitation power. In this ether an immense number of waves is being propagated in every possible direction; the waves themselves may be small, but their number renders them capable of exerting a finite and constant pressure at every point. Consider a body poised freely in space. For simplicity let it be a homogeneous sphere. This body will cast a penumbral shadow (if I may call it so when light-waves are not involved) out into space in every direction. As an example, I will take the

case of a body situated near the centre of a hollow sphere, the inner side of whose shell is aglow with light. Consider a particle distant d from the body, where d is infinitesimal compared to the radius of the illumined sphere. Now the diminution of light occasioned by the body as seen from the particle is obviously proportional to $\frac{1}{d^2}$. Now consider a similar system in the ether I have postulated. Let the body be A and the particle p. Then the diminution of pressure along Ap occasioned by the interception of waves by the dark body is proportional to $\frac{1}{d^2}$. But since the waves come in every direction and *in all four dimensions*, the diminution is also proportional to the length, breadth, thickness, and "fourness" of the body A. Therefore, the pressure along Ap (taking sense into account) is

$$\left(K - \frac{\lambda M}{d^2}\right) \text{ when } \lambda \text{ is a constant.}$$

But the pressure on p from the other side in the opposite direction pA is equal to K.

Accordingly the particle is being pressed towards the body A with a force equal to

$$K - \left(K - \frac{\lambda M}{d^2}\right) = \frac{\lambda M}{d^2},$$

a force directly proportional to the mass and inversely proportional to the square of the distance.

It is perfectly plain from the foregoing that the ether might be possessed of great density, since it bears the waves which cause gravitation itself, and therefore obviously cannot gravitate.

This theory also accounts for the instantaneity of gravitation. The most refined observations have failed to disclose any lapse of time between cause and effect where gravitation is concerned, and this would be wholly inconceivable were gravitation an inherent property of matter.

THE NEW ASTRONOMY.

MEETING OF THE PHYSICAL SOCIETY.

EXCEPT for the time spent on a paper on wireless detectors, the whole meeting of the Physical Society on Friday, May 30th, was occupied by a lecture by Professor Bickerton and a discussion on his theory of the origin of new stars. The lecturer began by showing that so many agencies tended to bring about stellar impact that these events must be scores of thousands of times more frequent than mere chance encounters would suggest. In fact, the impact of suns must be an important cosmic law. He then showed that all collisions of suns brought about by gravitation must be oblique; that is, of a grazing character. Some fifty years ago Dr. Johnstone Stoney had deduced this fact. It was accepted by Lord Kelvin, Sir Robert Ball, and Arrhenius. These eminent men had traced out in some detail the results that they thought would ensue. Owing to an oversight their work was valueless. They did not detect the fact that in solar grazes the shearing force available was millions of times greater than that necessary to cut the most tenacious of nickel steel, and that consequently grazing suns tear one another and the parts actually meeting coalesce to form a third star of such extreme thermodynamic intensity as to be explosively hot. Hence the problem of the encounter of suns must be taken in two parts: the new third star and the torn bodies of the suns.

Professor Bickerton then showed that the problems of all cosmic encounters must be divided, whether the collisions be between dense bodies such as suns or rare such as nebulae, meteoric swarms, or interpenetrating sidereal systems. In each case a central furnace, an explosively hot third body, must be formed. It was then shown that in any explanation of novae three most extraordinary criteria had to be satisfied. These were the thermodynamic intensity, the complex light-curve, and the long series of abnormal spectrograms. Every one of the current hypotheses failed in at least two, and most of them failed utterly in all three, criteria.

The induction that every nova is a third star torn from grazing suns satisfies all three criteria in the utmost minutia of detail. By the process of exhaustion this theory was the only explanation left. The shearing force available might be based on a velocity of two hundred and fifty miles a second, a velocity five hundred times that of a Krupp shell; that is, an energy of unit mass or kinetol a quarter of a million times that of our swiftest projectiles. The surface to be sheared is proportional to the square of the diameter of a sphere, whilst shearing force is as the mass; that is, as the cube of the diameter; and as the mass of the suns is quadrillions of times that of any military projectile there remains no question but that grazing suns shear one another. According to Dr. Crommelin, Nova Persei was estimated to have a maximum intensity ten thousand times that of the Sun. That is, were this tremendous blaze kept up by fuel, it would require to be stoked with six million times the entire coalfields of the earth each minute of its maximum. The impact of suns is the only known source of such a suddenly developed store of energy.

Professor Bickerton next pointed out that the third star would be formed in an hour, would expand, and would dissipate, giving a light-curve with a sudden uprise as novae always exhibit, whereas the commonly received explanation of Seleger and Halm, that of a sun entering a nebula, must give a light-curve almost horizontal. The explanation given in the lecture followed that in "KNOWLEDGE" (September, 1911), as did also the explanation of the series of spectrograms, Professor Bickerton stated that although such physical agencies as pressure might account for some of the peculiarities of the spectra of novae there was no need to bring in anything but the Doppler principle. This, taken in conjunction with the deduced properties of the third star, was sufficient to account for any physical fact even of so complex spectra as those of Nova Geminorum as obtained at Cambridge.

The Chairman, Professor Schuster, F.R.S., stated that the whole theory was extremely suggestive, and that Professor Bickerton had devoted a third of a century to its study. There was one point he should like discussed, and that was the high velocity of hydrogen referred to. Experimentally it had been shown that, no matter how enormous the pressure to which the gas was subject, the velocity of escape never rose above that of sound.

Professor Bickerton replied that the velocities observed in novae was a question of temperature, not pressure. The velocity of sound was a question of thermodynamics. If the compressed hydrogen had the enormous temperature attained during and subsequent to the collision the velocity of sound would be proportionally increased.

A hearty vote of thanks was accorded to the lecturer.

XUM

THE MAKING OF A MICROSCOPE.

By WILFRED MARK WEBB, F.L.S.

With Illustrations from Photographs specially taken by Messrs. Lascelles & Co.

THE microscope has come to be used in so many branches of scientific research, and, we may add, of everyday commerce, that it has occurred to us that a short illustrated account of the way in which the instrument is made would be of interest to our readers. Accordingly Messrs. W. Watson & Sons were approached, and they kindly gave permission for their works at High Barnet to be visited, and afforded all the necessary facilities for taking the photographs from which our illustrations have been made.

The work may well be divided into two parts, and we may consider it under two headings: firstly, the making of the metal stand and fittings; and secondly, of the optical parts, or, in that slang which the Royal Microscopical Society is content to use, "brass" and "glass." Figure 246 shows a general view of the machine shop where the metal parts of microscopes, and also of telescopes, field glasses, and so on, are got into shape. It may be said at once that the rough castings (see Figure 250) are not made at the works. The first process through which the foot, for instance, of a microscope is put is grinding, by which the flat surfaces are made true, as shown in Figure 247.

The surfaces which cannot be ground are milled—that is to say, cleaned up in the machine provided with a revolving wheel furnished with a number of cutting teeth (see Figure 249).

At the back of the machine shop is a room containing the forges and also an interesting machine, shown in Figure 248, which gives a very great mechanical advantage, by means of which the brass tubing used for the bodies of microscopes and other instruments is brought to the exact size required; the tubing is pulled over a metal core of the exact diameter which is required through a hole in an iron plate which corresponds with the outside measure. It may be added that the tubing is made smaller during the operation and is lengthened considerably, while its hardness is very greatly increased.

Turning to other parts of the microscope stand it is not necessary to describe the turning and screw-cutting in connection with various fittings; but to give some idea of the accuracy which has to be obtained it may be mentioned that in the case of the screw-threads in telescopes which are made for Government an error of only $\pm$ ·0005 of an inch is allowable. In a smaller shop special work is done. For instance, it is found necessary, when making the surfaces true which are to be moved by the fine adjustment of the microscope, that this should be done on a planing machine worked by hand, as shown in Figure 251. The processes of blackening and bronzing differ but little, if at all, from those in use in the case of other metal work, and we may leave the making of the stand on one side for a moment to consider the very important question of lens grinding.

The special optical glass which is imported for the purpose of lens-making is received in small slabs, of which half a dozen are shown in Figure 252. These are slit up into pieces, which are of the required thickness and size, by means of an apparatus similar to that used for slicing precious and ornamental stones. It is, for all practical purposes, a circular saw in the form of a revolving metal disc, the teeth of which consist of diamond dust hammered into its edge. The machine and discs used are represented in Figure 253, where a block of glass partly sawn through is seen in position.

The next operation is to trim up the square pieces of glass so as to make them approximately circular by clipping them with shears. They are then ground or roughed into shape (see Figure 254), and afterwards taken to the glass shop, a view in which is seen in Figure 261. Here the larger lenses for eyepieces and low-power objectives are polished and made true, and we illustrate the details of the process in Figure 255, where blocks of lenses are seen, showing how convex, concave, and plane surfaces are produced. The polishers are fastened to a crank which causes them to rotate with the particular motion required. It should be mentioned that fine rouge is used at this stage.

Small microscope lenses are fastened on to a block in the same way and held by the hand into a revolving cup, as seen in Figure 256, while very small ones for high-power objectives are fixed singly to handles and polished individually. A pair of holders may be seen lying on the table in the figure just mentioned.

From time to time as the work proceeds the lenses are tested with a proof plate, the surface of which, in the case of convex lenses, of course, will be concave, and *vice versa*. The method of applying this is seen in Figure 257 in the case of a good-sized lens, and the proof that the latter is accurately ground is shown when it is brought into contact with the plate by the formation of a perfect series of Newton's rings. After the lens is polished its edges have to be ground, and we illustrate this in Figures 258 and 259 in the case of a large lens, and also that of one which is to be used in the making of a one-twelfth objective. Putting together one of the latter is, of course, a most delicate process and requires great skill. The flint and crown glass constituents of the lenses have first of all, as in other cases, to be cemented together and then the whole series has to be mounted in the metal fittings and adjusted. This is done at Messrs. Watson & Sons' works by means of measurements, with the result that very few of the finished objectives, which are turned out in considerable numbers, do not pass the test the first time.

Now we may consider that we have all the parts of

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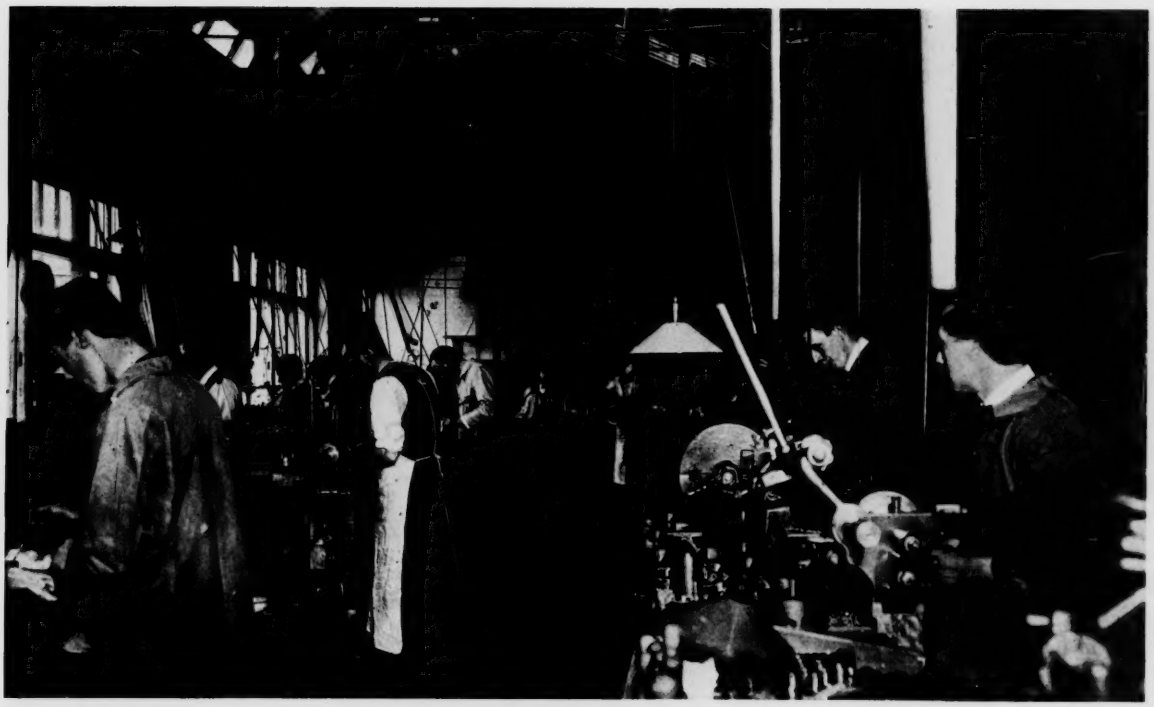

FIGURE 246.
The machine shop at Messrs. W. Watson & Sons' Works, High Barnet.

FIGURE 247.
Making flat surfaces of a casting true with a grindstone.

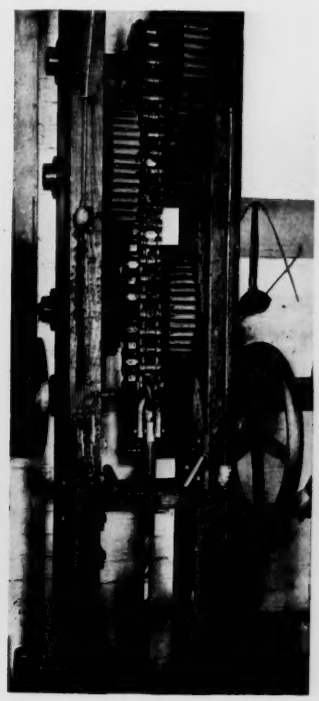

FIGURE 248.
The machine for drawing out brass tubing.

FIGURE 249.
Milling or cleaning up the parts of a casting.

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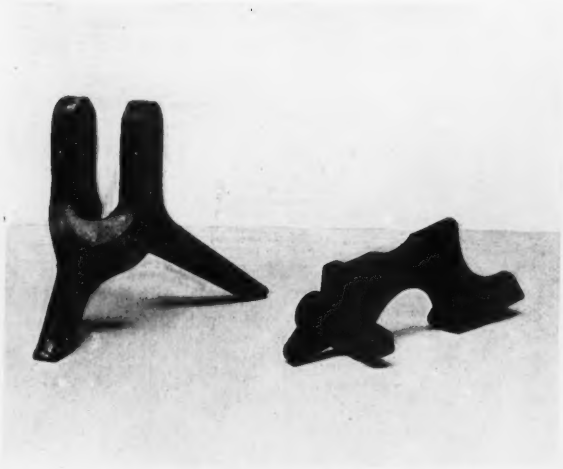

FIGURE 250.
Rough castings as received at the works.

FIGURE 251.
Planing the surface of a fine adjustment by hand.

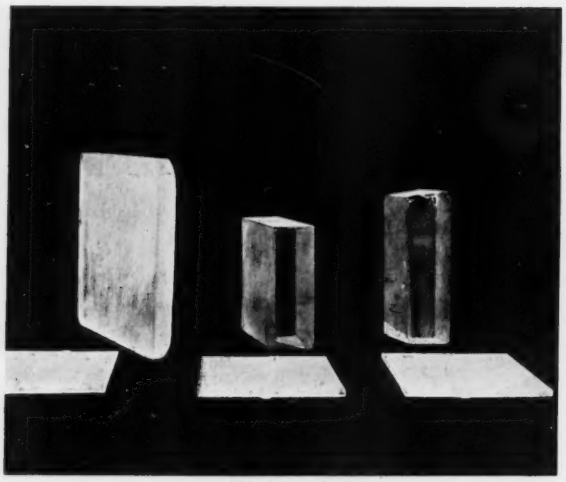

FIGURE 252.
Optical glass as imported.

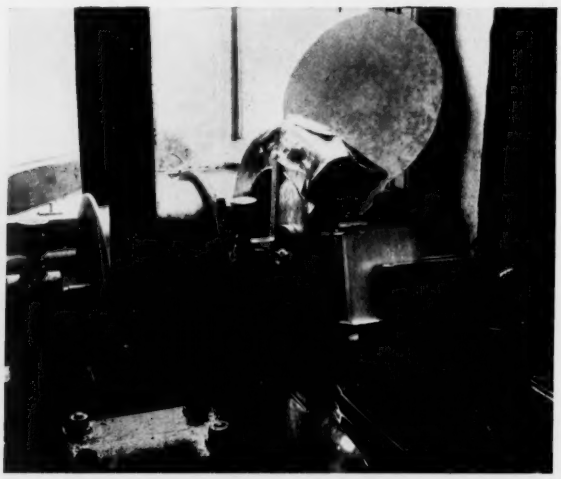

FIGURE 253.
Machine for slitting the glass.

FIGURE 254.
Roughing or getting the lenses into shape for polishing.

FIGURE 255.
Lens polishing machine with blocks of lenses.

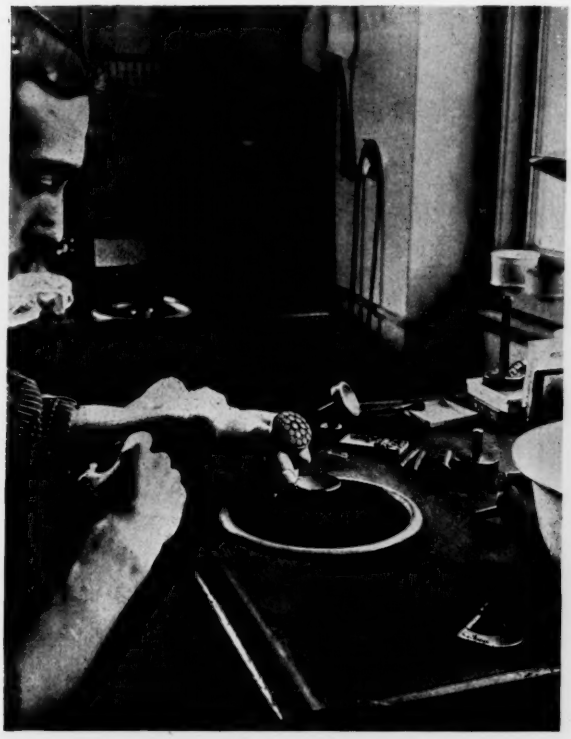

FIGURE 256.
Grinding small lenses by hand.

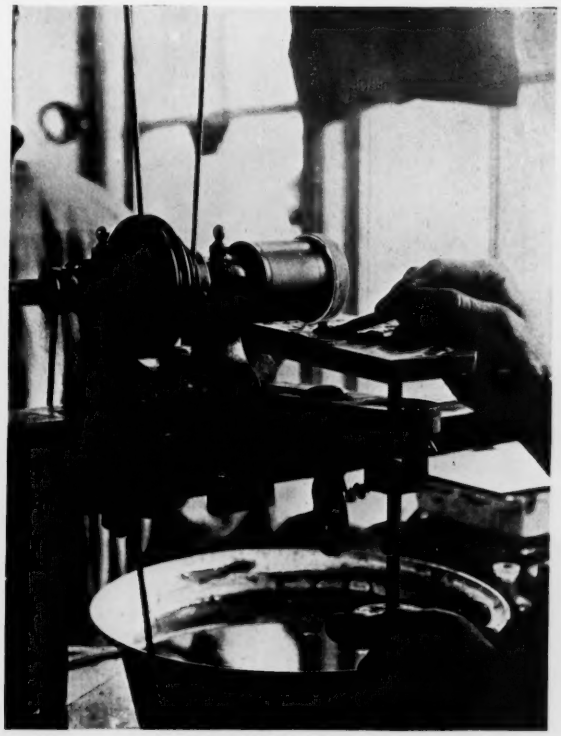

FIGURE 258.
Grinding the edge of a finished lens of considerable size.

FIGURE 257.
Testing a lens with a proof plate.

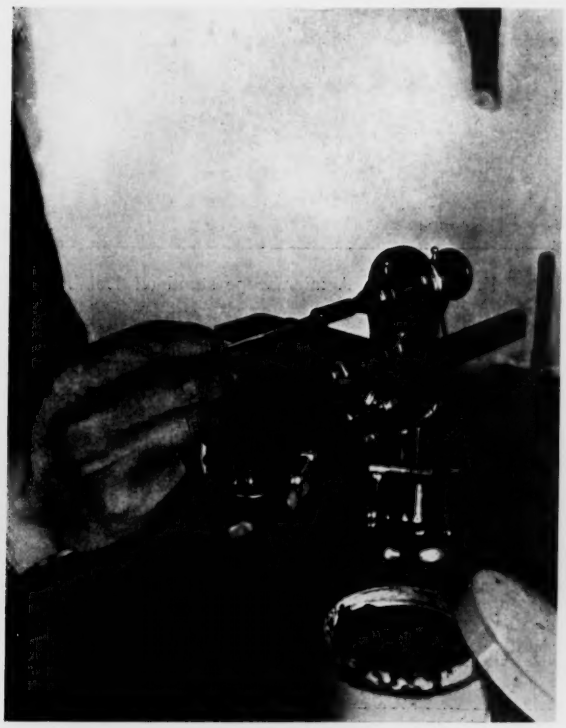

FIGURE 259.
Grinding the edge of a lens for a one-twelfth objective.

XUM

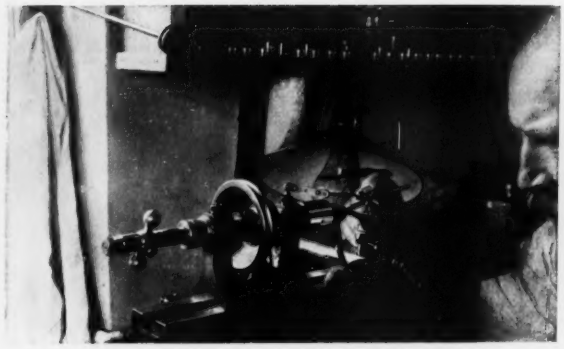

FIGURE 260.
Mounting the lenses for a one-twelfth objective.

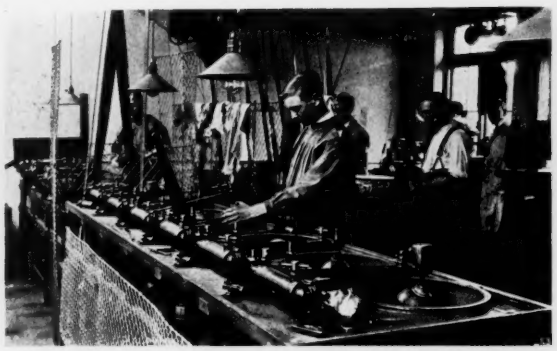

FIGURE 261.
A view in the glass shop.

FIGURE 262. A microscope stand (H Edinburgh Student's) with its components and their individual pieces.

FIGURE 263.
Assembling a microscope.

FIGURE 264.
The testing-room examination.

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XUM

the microscope ready, and to give some idea of how many of them there are we show in Figure 262 the more important portions of an H Edinburgh Student's Microscope and the separate pieces of which they are made up. It may surprise some of our readers to learn that there are sixty-four of these and ninety-six screws in the stand alone.

To assemble a microscope is the term used for putting the stand together—that is, combining the stage, foot, limb, and mirror (see Figure 263). After this the instrument has to go through the testing room examination (see Figure 264), when it is ready to leave the works and be fitted with such eyepieces and objectives as its future owner needs for his work.

CORRESPONDENCE.

QUADRATURE OF THE CIRCLE.

To the Editors of "KNOWLEDGE."

SIRS,—In "KNOWLEDGE" for November last you published a letter from me touching the quadrature of the circle. In this letter I asked certain questions on the subject. I also stated that I had ascertained *by geometry* that the perimeter of a circle is equal to a certain triangle described on same.

Up to date no reply to the questions referred to has appeared in "KNOWLEDGE," and I am still holding in abeyance the geometric solution referred to pending satisfactory answers from some source to these queries.

What I wish to be informed on is:—

1st, Has the solution referred to above ever been published or made known before it appeared in "KNOWLEDGE," *i.e.*, either in ancient or modern works?

2nd, Has it ever been satisfactorily proved or disproved in any way by any author?

One gentleman did write to you on the subject, but he made no reference whatever to these questions, although he criticised the solution.

In reply to this writer I give Figure 265, showing that the solution is exact and not approximate only.

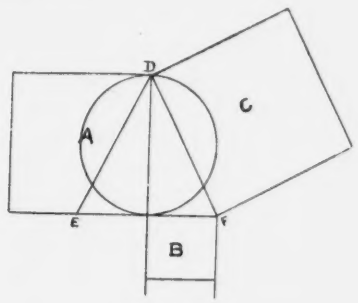

FIGURE 265.

By ordinary geometry the square C is = A and B together.
Let diameter = 1.
The square A = 1.
And square B = ·25.
And therefore square C = 1·25.
Also square on E D F will = 5 (1·25 + 4).
And square on E F will = 1.
Therefore E D F = $\sqrt{5}$ and E F = $\sqrt{1}$.
And therefore E D F E = $\sqrt{5} \times \sqrt{1}$.

Arithmetic of the Quadrature.

I also send Figure 266 for the purpose of showing that my geometric solution referred to above can be verified by arithmetic.

Attention may be drawn to the following points:—

1st, The whole of the ratios given are based on the square root of 5 and the square root of 1 (which, of course, is 1), and that they are therefore commeasurable.

2nd, The ratio of the circumference of the circle to its diameter is identical with the ratio of—

(*a*) The area of the outer circle, minus the square to
(*b*) The area of the square, minus the inner circle, *i.e.*, the ratio of (*a*) to (*b*) or of E to D in the diagram.

Table 46 shows the results of using any different ratio from $\sqrt{5} \times \sqrt{1}$:

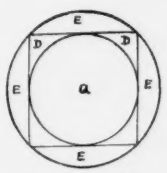

FIGURE 266.

A The inner circle-area $\sqrt{5} + \sqrt{1} + \cdot 25$ ($\frac{1}{2}$ radius).
B The square-area $\sqrt{5} \times \sqrt{1} + E \div 2$.
C The outer circle-area $\sqrt{5} \times \sqrt{1} + \sqrt{2} + (\cdot 25 + \sqrt{2})$.
D The four spaces D singly or together.
E The four spaces E singly or together.

Ratios (taken inversely, etc.):

Circumference to diameter ...	$\sqrt{5} \times \sqrt{1}$
E to D	$\sqrt{5} \times \sqrt{1}$
The square to the lesser circle	$\sqrt{5} \times \sqrt{1} - 2$
The greater circle to the square	$\sqrt{5} \times \sqrt{1} \div 2$
A to E	$\sqrt{5} \times \sqrt{1} \div 2 - \frac{E}{2}$
A to D	$\sqrt{5} \times \sqrt{1} \times \sqrt{1}$

TABLE 46.

Ratio of Perimeter to Diameter.	Area.	Spaces E Equal.	Spaces D Equal.	Ratio of E to D.
3	·75	·5	·25	2
3,2	·8	·6	·2	3
($\sqrt{5} \times \sqrt{1}$) 3,236, etc.	·809, etc.	·618, etc.	·1909, etc.	($\sqrt{5} \times \sqrt{1}$) ·3236, etc.
3,3	·825	·65	·175	·3714, etc.
3,5	·875	·75	·125	6

These figures (and any further calculations that may be made on the same lines) show conclusively that the figures of the ratio "$\sqrt{5} \times 1$" are the most "symmetral" that can be produced in conjunction with Figure 266.

Therefore, if they are not the true figures of the circle, there must be some other figures or polygon (regular or irregular) to which they do apply; and it will also follow that this other figure is a more symmetrical figure than the circle—which is impossible.

On the strength of what I have advanced above, I hope some scholar will now answer the questions given above.

BRISBANE, QUEENSLAND. GEOMA.

XUM

THE FACE OF THE SKY FOR AUGUST.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 47.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A	Mars. Dec	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
Aug. 3	8 51·9	N. 17·6	9 48·6	N. 15·1	8 53·1	N 12·4	5 48·3	N. 21·1	4 6·1	N. 20·1	18 41·7	S. 23·3	4 56·8	N. 21·0	20 31·6	S. 19·6
,, 8	9 11·1	16·3	14 12·9	S. 17·1	8 39·5	12·9	6 12·0	21·4	4 19·9	20·7	18 39·9	23·3	4 58·7	21·1	20 30·8	19·6
,, 13	9 30·1	14·8	18 55·9	S. 27·8	8 32·9	15·5	6 36·0	21·4	4 33·6	21·3	18 38·2	23·3	5 0·5	21·1	20 30·0	19·7
,, 18	9 48·8	13·2	22 58·6	S. 7·7	8 37·7	16·7	7 0·2	21·3	4 47·2	21·8	18 36·9	23·4	5 2·1	21·2	20 29·2	19·7
,, 23	10 7·3	11·6	2 34·6	N. 19·3	8 54·8	17·0	7 24·7	20·9	5 0·7	22·2	18 35·8	23·4	5 3·6	21·2	20 28·5	19·7
,, 28	10 25·7	N. 9·8	7 21·1	N. 27·0	9 22·4	N. 16·1	7 49·2	N. 20·2	5 13·9	22·6	18 35·3	S. 23·4	5 4·9	N. 21·2	20 27·8	S. 19·8

TABLE 48.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Aug. 3	+11·7	+6·0	60·7	+18·3	−34·7	−8·5	157·5	1 12 *m*	−5·3	−1·6	143·0	97·5	5 56 *e*	7 15 *e*
,, 8	13·6	6·3	354·6	+18·3	33·9	7·2	109·0	4 32 *m*	5·1	1·6	212·7	129·1	4 2 *e*	6 23 *e*
,, 13	15·4	6·6	288·5	− 5·1	33·0	5·9	60·5	7 51 *m*	4·9	1·6	282·3	160·6	11 58 *e*	5 31 *e*
,, 18	17·1	6·8	222·4	−21·1	32·1	4·7	12·0	11 11 *m*	4·8	1·6	351·9	191·9	10 4 *e*	4 39 *e*
,, 23	18·7	7·0	156·3	−17·1	31·0	3·4	323·6	2 29 *e*	4·7	1·6	61·3	223·2	8 10 *e*	3 47 *e*
,, 28	+20·1	+7·1	90·3	+ 7·4	−29·9	−2·2	275·3	5 48 *e*	−4·6	−1·6	130·7	254·4	6 17 *e*	2 55 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, L_1 refers to the equatorial zone; L_2 to the temperate zone; T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues his Southward march with accelerated speed. Sunrise during August changes from 4.23 to 5.13; sunset from 7.49 to 6.48. Its semi-diameter increases from 15′ 47″ to 15′ 53″. Outbreaks of spots in high latitudes should be watched for.

MERCURY is in Inferior Conjunction at Noon on August 4th; then it is a morning star, reaching West Elongation (18° from Sun) on 22nd. Illumination increases from 0 to $\frac{7}{16}$. Semi-diameter diminishes from $5\frac{1}{2}$″ to 3″.

VENUS is a morning star, having passed West Elongation July 4th. Semi-diameter diminishes from 9″ to 7″. At beginning of month $\frac{5}{6}$ of disc is illuminated; at end of month $\frac{3}{4}$. Being North of Sun it is favourably placed for Northern observers. It is 18′ South of Neptune $30^d\ 0^h\ 38^m m$.

THE MOON.—New $2^d\ 0^h\ 58^m e$; First Quarter $9^d\ 4^h\ 3^m m$; Full $16^d\ 8^h\ 27^m e$; Last Quarter $25^d\ 0^h\ 18^m m$. New $31^d\ 8^h\ 38^m e$. Perigee $3^d\ 11^h e$, semi-diameter 16′ 36″. Apogee $19^d\ 8^h m$, semi-diameter 14′ 44″. Maximum Librations, 10^d 7° W, 12^d 7° N., 26^d 7° E., 26^d 7° S. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

TABLE 49. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
Aug. 8 ...	BAC 4814	6·5	8 33 *e*	185°	8 53 *e*	219°
,, 12 ..	Lacaille 7730	7·0	10 11 *e*	81	—	—
,, 13	BAC 6628	5·9	9 26 *e*	100	10 40 *e*	230
,, 15 ...	χ Capricorni	5·3	9 31 *e*	105	10 32 *e*	202
,, 18 ...	BAC 8129	6·3	8 15 *e*	68	9 22 *e*	232
,, 19 ...	BAC 8184	6·4	3 9 *m*	117	3 42 *m*	169
,, 20 ...	BD−0°6	7·6	—	—	1 38 *m*	179
,, 24 ...	BD+24°599	6·6	—	—	11 41 *e*	225
,, 26 ...	BD+27°723	6.5	3 39 *m*	52	4 46 *m*	280
,, 26 ..	BAC 1848	5·6	—	—	10 51 *e*	298
,, 26 ...	136 Tauri	4·6	11 9 *e*	157	11 22 *e*	189
,, 28 ..	47 Geminorum...	5·6	4 57 *m*	120	5 59 *m*	249

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.
The grazing occultation of 136 Tauri on 26th should be carefully observed; sometimes more than one disappearance or reappearance takes place in such cases, owing to irregularities in the lunar outline.

MARS is a morning Star, semi-diameter 3½″, defect of illumination nearly a second. It is 1° North of Saturn, $24^d\ 5^h e$. It will reach Opposition early in January, so the season of observation is commencing.

VESTA is in opposition August 4th, magnitude 6·1. Ephemeris for midnight:—

	R.A.	S.Dec.
	h m	°
August 2... ...	20 59·3 ...	23·2
,, 8... ...	20 53·6 ...	24·0
,, 14... ...	20 48·1 ...	24·6
,, 20... ...	20 43·1 ...	25·1

It will be interesting to compare it with Uranus, which is not far distant. Their magnitude is about the same, but their aspect different.

JUPITER was in opposition on July 5th. Polar semi-diameter, 20¾″ in mid-August.

TABLE 50.

Day.	West.	East.	Day.	West.	East.
Aug. 1	2 ○	34 1 ●	Aug 17		○ 1234
,, 2	21 ○	34	,, 18	13 ○	24
,, 3	○	1324	,, 19	32 ○	14
,, 4	31 ○	24	,, 20	312 ○	4
,, 5	32 ○	14	,, 21	3 ○	124
,, 6	31 ○	4 2 ●	,, 22	12 ○	34
,, 7	43 ○	12	,, 23	2 ○	143
,, 8	42 ○	3 1 ●	,, 24	4 ○	23 1 ●
,, 9	421 ○	3	,, 25	41 ⊙	2
,, 10	4 ○	123	,, 26	432 ○	1
,, 11	413 ○	2	,, 27	4312 ○	
,, 12	432 ○	1	,, 28	43 ○	12
,, 13	431 ○	2 ●	,, 29	41 ⊙	3
,, 14	43 ○	12	,, 30	42 ○	13
,, 15	21 ○	3 4 ●	,, 31	4 ○	23 1 ●
,, 16	2 ⊙	43			

Configuration at $9^h\ 30^m e$ for an inverting telescope.

Satellite phenomena visible at Greenwich, $1^d\ 0^h\ 31^m m$ I. Tr. E., $0^h\ 35^m\ 53^s m$ III. Ec. R., $1^h\ 9^m m$ I. Sh. E., $10^h\ 26^m\ 51^s e$ I. Ec. R.; $5^d\ 0^h\ 33^m m$ II. Tr. E.; $6^d\ 11^h\ 0^m\ 52^s e$ II. Ec. R.; $7^d\ 10^h\ 15^m e$ III. Oc. D., $10^h\ 34^m e$ IV. Sh. E.; $8^d\ 0^h\ 0^m m$ I. Tr. I., $0^h\ 46^m m$ I. Sh. I., $9^h\ 18^m e$ I. Oc. D.; $9^d\ 0^h\ 21^m\ 36^s m$ I. Ec. R., $8^h\ 44^m e$ I. Tr. E., $9^h\ 33^m e$ I. Sh. E.; $13^d\ 9^h\ 3^m e$ II. Oc. D.; $15^d\ 8^h\ 19^m e$ IV. Oc. D., $8^h\ 42^m e$ II. Sh. E., $11^h\ 6^m e$ I. Oc. D., $11^h\ 14^m e$ IV. Oc. R.; $16^d\ 8^h\ 14^m e$ I. Tr. I., $9^h\ 10^m e$ I. Sh. I., $10^h\ 32^m e$ I. Tr. E., $11^h\ 28^m e$ I. Sh. E.; $17^d\ 8^h\ 45^m\ 8^s e$ I. Ec. R.; $18^d\ 10^h\ 30^m e$ III. Sh. E.; $20^d\ 11^h\ 25^m e$ II. Oc. D., $22^d\ 8^h\ 27^m e$ II. Sh. I., $9^h\ 15^m e$ II. Tr. E., $11^h\ 18^m e$ II. Sh. E.; $23^d\ 10^h\ 3^m e$ I. Tr. I., $11^h\ 5^m e$ I. Sh. I.; $24^d\ 0^h\ 21^m m$ I. Tr. E., $7^h\ 21^m e$ I. Oc. D., $10^h\ 40^m\ 2^s e$ I. Ec. R.; $25^d\ 7^h\ 53^m e$ I. Sh. E., $10^h\ 8^m e$ III. Tr. E., $11^h\ 9^m e$ III. Sh. I.; $29^d\ 8^h\ 49^m e$ II. Tr. I., $11^h\ 2^m e$ II. Sh. I., $11^h\ 39^m e$ II. Tr. E., $30^d\ 11^h\ 53^m e$ I. Tr. I.; $31^d\ 8^h\ 12^m\ 5^s e$ II. Ec. R., $9^h\ 11^m e$ I. Oc. D.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Dec.	Remarks.
	°	°	
May 30 to Aug	333	+ 28	Swift, streaks.
June to Aug...	310	+ 61	Swift, streaks.
,, to Sep. ..	335	+ 57	Swift.
,, to Aug....	303	+ 24	Swift.
July to Aug...	308	− 12	Slow, long.
July 25 to Sept. 15	48	+ 43	Swift, streaks.
July to Sept.	335	+ 73	Swift, short.
July to Aug....	280	+ 57	Slow, short.
July to Oct. ..	355	+ 72	Swift, short.
Aug. 10-13 ..	45	+ 57	Perseids. Swift, streaks.
,, 15 ..	290	+ 53	Swift, bright.
,, 15-25 ..	291	+ 60	Slow, bright.
,, 25 ..	5	+ 11	Slow, short.
Aug. to Sept. .	353	− 11	Rather slow.
,, ,,	346	0	Slow.
Aug. to Oct. 2	74	+ 42	Swift, streaks.
,, to Sept...	63	+ 22	Swift, streaks.

The Perseids may be seen from July 19th, radiant 23° + 52°, advancing 1° per day in R.A.

TABLE 51. NON-ALGOL STARS.

Star.	Right Ascension.	Declination	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
T Herculis	18 6	+31·0	6·9 to 13	165	May 2, Oct 13.
RY Ophiuchi...	18 12	+ 3·6	8·2 to 13	153·3	July 14.
W Lyrae	18 12	+36·6	7·3 to 12	190·5	May 28.
RS Draconis	18 40	+74·2	8·4 to 12	281	June 29.
SU Sagittarii	18 59	−22·8	8·3 to 9	88	May 18.
R Aquilae	19 2	+ 8·1	6·2 to 11	337	May 15.
W Aquilae	19 11	− 7·2	8·2 to 13	489	July 24.
R Sagittarii	19 12	19 5	7·0 to 13	269	Aug. 16.
T Sagittae	19 18	+17·5	8·3 to 9·5	156·7	June 14.
AF Cygni	19 27	+46·0	7·0 to 8·0	·94	May 11, Aug. 13
TY Cygni	19 30	+28·1	8·7 to 13	354	June 22.
RT Aquilae	19 34	+11·5	7·6 to 12	325	Sept. 4.
RT Cygni	19 41	+48·5	6·6 to 12	190·5	Mar 22.
TU Cygni	19 44	+48·8	8·5 to 14	225	July 21.
X Aquilae	19 47	+ 4·2	8·2 to 10	348	Aug. 18.
RU Aquilae	20 9	+12·7	7·9 to 14	276	Aug. 22.
R Sagittae	20 10	+16·5	8·5 to 10	70·6	July 20, Sep. 29.
AI Cygni	20 28	+32·2	8·6 to 9·7	173	Aug. 27.
V Cygni	20 38	+47·8	6·8 to 14	418	June 29.
T Aquarii	20 45	− 5·5	6·8 to 13	202·7	July 30.
R Vulpeculae...	21 1	+23·5	7·1 to 13	136·8	Aug. 30.
T Cephei	21 8	+68·2	5·2 to 11	387	Oct. 24.
SW Pegasi	21 18	+21·6	8·7 to ?	175	July 10.
YY Cygni	21 19	+42·0	8·5 to 9·5	378	Sep. 29.
S Cephei	21 36	+78·2	7·0 to 13	486	June 24.
V Pegasi	21 57	+ 5·7	7·8 to 14	303	Sep. 8.

β Lyrae minima Aug. $10^d\ 7^h m$, $23^d\ 4^h m$, Period $12^d\ 21{\cdot}8^h$.

Algol minima Aug. $8^d\ 4^h\ 51^m m$, $13^d\ 10^h\ 29^m e$, $31^d\ 3^h\ 22^m m$, Period $2^d\ 20{\cdot}8^h$.

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SATURN is a morning star, coming into a better position for observation. Polar semi-diameter $8\frac{1}{2}''$. P. is $-4°\cdot7$; ring major axis $41\frac{1}{2}''$, minor $18\frac{1}{2}''$. The ring is very widely open. It is of interest to examine the exact amount of overlap beyond the planet's pole.

East Elongations of Tethys (every fourth given), $4^d\ 11^h\cdot7m$, $12^d\ 1^h\cdot0m$, $19^d\ 2^h\cdot3e$, $27^d\ 3^h\cdot6m$; Dione (ever third given), $5^d\ 2^h\cdot5m$, $13^d\ 7^h\cdot7m$, $21^d\ 0^h\cdot8e$, $29^d\ 6^h\cdot0e$; Rhea (every second given), $6^d\ 1^h\cdot7m$, $15^d\ 2^h\cdot8m$, $24^d\ 3^h\cdot8m$. For Titan and Iapetus E.W. mean East and West Elongations, I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $2^d\ 5^h\cdot7e$ W., $6^d\ 5^h\cdot3e$ S.; $10^d\ 8^h\cdot9e$ E., $14^d\ 9^h\cdot4e$ I., $18^d\ 6^h\cdot0e$ W., $2^d\ 5^h\cdot6e$ S., $26^d\ 9^h\cdot1e$ E., $30^d\ 9^h\cdot1e$ I.; Iapetus, $20^d\ 8^h\cdot6e$ W.

URANUS was in opposition on July 29th. Semi-diameter, $1\frac{3}{4}''$. At end of August, 2° S.E. of ρ Capricorni.

NEPTUNE is too near the Sun for observation, having been in conjunction on July 19th.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 18^h to 22^h, next month 20^h to 0^h, and so on.

CORRESPONDENCE.

NOTE.—*We have received a communication from Dunford Bridge relating to Professor Thomson's note on reproductive harmony in the wild duck (see "Knowledge," Volume XXXVI, number 538, page 187), and one from "Old Planter," but as the writers have forgotten to attach their names, according to our rule, we are not able to print the letters.*

ASTRONOMICAL PHOTOGRAPHY.

To the Editors of "KNOWLEDGE."

SIRS,—Would you be so kind as to give me some hints about astronomical photography. I have an ordinary quarter-plate hand-camera, and a $2\frac{1}{4}''$ refracting telescope. I should be extremely grateful for any advice on the subject.

W. P. WILLIAMS.

ARLINGTON PARK COLLEGE,
CHISWICK.

In answer to the above letter, Mr. J. Milton Offord, F.R.M.S., has kindly sent the following note.

SIMPLE DIRECTIONS FOR PHOTOGRAPHY WITH A SMALL TELESCOPE.—Photography of the Sun may be taken with a very small telescope, using an enlarging lens in place of the eyepiece and a screen close over the plate. The exposures are so short that a fixed telescope will answer.

For the Moon use the fastest plates obtainable with an enlarging lens. Exposures of about one second at full aperture can be given and the amount of enlargement possible is dependent on the aperture of the telescope. Images about one-inch diameter with a two-inch telescope should show a good deal of detail.

Planetary photography is beyond the reach of a small telescope, except in the case of Venus, where the crescent form can be photographed with an enlarging lens.

For stellar photographs use the telescope as a guide to an ordinary camera firmly attached to it. With patience, good photographs may be taken by keeping a bright star in the centre of the field of the guiding telescope. This is best done by bisecting the out-of-focus image of the star with cross wires in the eyepiece. Even a simple pillar and claw stand may be used, but it is essential to balance well the telescope and secure a comfortable rest for the observer's head and arm.

The apparatus needed is quite simple: a light-tight tapering box, securely fastened to the outside of the eye end of the telescope leaving the rack tube free; a focusing glass, finely ground, with its centre rendered transparent by a microscopic cover glass being cemented to it with Canada balsam; a plate-holder as light as possible; a simple magnifying glass in a screw mount for focusing, and a dark card to cover the object-glass end of the telescope will be required. The enlarging lens is important; it takes the place of the ordinary eyepiece, and the best form is a triple-cemented lens on Steinheil's principle, as used for dissecting microscopes; cost about 10/-. This kind of lens passes a great deal of light and gives sharp images.

To take a photograph, say, of the moon: First obtain the actinic focus, if a refracting telescope, by trial. To do this mark the draw-tube roughly in fractions of an inch, say for half an inch, round the visual focus; then make a number of exposures at different focal lengths until the best result is obtained. When this is found, the focusing lens can be adjusted to view the moon through the central clear space in the ground glass, and with the telescope at best actinic focus, made to give good visual focus and fixed there, so that ever after when focusing with this lens it will be the true focus for photography.

Having obtained the focus, cover the object glass with the cap. Set the telescope in advance of the Moon and wait until the Moon's image will be central, having the plate open, and then expose by removing and replacing the card. It is best to have the card larger than the aperture and hold it in front for a while before exposing, to prevent shaking the telescope, quickly moving it to one side and back again to expose.

For developers Metol Hydrokinone or Paramidophenol are good. For plates, Imperial Flashlight or Lumiére Sigma answer well; they should, of course, be backed.

THE "FOURTH DIMENSION."

To the Editors of "KNOWLEDGE."

SIRS,—There is one statement in Mr. Redgrove's letter in the June number of "KNOWLEDGE" to which I ought to reply He says that he had "already intimated" that he did not intend to discuss the question further with me. This is not correct; what he said does not bear this meaning. However, I have no wish to continue the correspondence, and, since he does not wish to reply to my letter in the April number of "KNOWLEDGE," I am quite content that what is contained in that letter should remain the final statement of the issue between us.

JOHN JOHNSTON.

HENDON, N.W.

THE PLANET MARS.

To the Editors of "KNOWLEDGE."

SIRS,—A copy of your Journal for May, 1913, has been sent me, apparently to call my attention to, and perhaps secure my comment upon, an article denying the reality of the canals of Mars. Comment on the argument is unnecessary, but the statement on the first page, that Schiaparelli is responsible for the theory of their artificiality, should be corrected. The blame for the discovery rests wholly on me. His theory was that they were natural channels, though, with the magnanimity and open-mindedness of genius, he wrote to me before his death: "Votre théorie devient de plus en plus probable."

PERCIVAL LOWELL.

LOWELL OBSERVATORY,
FLAGSTAFF, A.T.

THE TRUE CAUSE OF SEA-SICKNESS.

By H. NORMAN BARNETT, F.R.C.S.

THE questions "To what is sea-sickness really due?" "Is there any cure?" have often presented themselves to the minds of the general public.

There is probably no ill which flesh is heir to that has a more constant interest, especially in these days of travel; for it presents itself to the week-ender crossing from Dover to Calais as well as the traveller to the Far East or West.

There is no minor ailment—minor so far as its pathology is concerned—which causes so much discomfort, none which gains so little sympathy from those unaffected by it, and has had such divergent prescribing with so little good result.

There are many theories of the cause of sea-sickness. I have had proof of the untrustworthiness of most of them. What is known as the "endolymph" theory is, however, scientifically accurate and supported by much practical evidence of its truth.

Having once found a cause which is a satisfactory explanation of the various phenomena of sea-sickness, its prevention and even cure become a comparatively simple matter; for we have in the bromides drugs which, when properly handled, are capable of good results in the treatment of this disorder.

The sickness which occurs when crossing the Channel or the Irish Sea, and vanishes when the boat reaches its destination, is vastly different from that arising in the Indian Ocean during the south-west monsoon, when for a week the ship is violently pitching, so that even seamen have difficulty in remaining in their bunks at night. Supposing a patient to be in delicate health, or suffering from some concomitant ailment, the results may be most serious.

I have met many cases where great prostration had to be faced; others where haemorrhage threatened a phthisical patient. Many patients who are often thoughtlessly ordered abroad for their relief or cure may be reduced to a very serious condition. I am glad to note a change in this respect, but many are still sent on long sea voyages who could be much better treated in a sanatorium at home.

Sad cases are often seen of those in the second and even third stages of phthisis who have been enabled to take the voyage with much financial difficulty, and have to make it as one of three or four in a small third-class cabin. Such patients, often unable to touch the food—good, but rather coarse—are particularly bad subjects should the ship encounter rough weather. They are usually violently ill, and have to remain in lower-deck cabins, with every porthole closed. The atmosphere of such a cabin teems with tubercle bacilli and other forms of germ life inimical to health. The result is that the unfortunate patient lands, if he survive, on some distant shore a piteous wreck, friendless, probably almost penniless, in every way worse than when he left England, having on the journey probably caused infection to more than one cabin-mate.

The only class of phthisical patient that should be allowed to go for a long voyage on a passenger ship is one in the first stage of the disease, who can afford to have an entire first- or second-class cabin, with plenty of air space, to himself. If bad weather be met with, fair ventilation can then be secured. This minimises the risk of sea-sickness for the patient, and danger to others is avoided. A sea voyage is very beneficial for those suffering from surgical tuberculosis so long as the cases are not too advanced.

I would designate *sickness at sea* as that which is produced in a person whose digestive organs are at fault in one way or another, and which is often confounded with true sea-sickness. I feel sure that all who give any thought to the matter will find an explanation in this of cases which are evidently not explicable on the theory to which I shall presently refer. They are, in fact, cases of severe sick headache which might occur anywhere.

The origin of sea-sickness is not so apparent as many seem to think. That the exciting cause is the motion produced by a ship on a rough sea is the indefinite reason assigned, but it should be remembered that there are many predisposing causes and circumstances that modify the exciting one.

Predisposing Causes may be divided into those connected with the stomach, those connected with liver, those connected with the nervous system, and those connected with the ship.

Those connected with the Stomach have had too great stress laid upon them. In the healthy individual symptoms referable to the stomach are secondary, being the result, not the cause, of the malady. In those who are suffering from gastric disturbance, either chronic or acute, or who go on board a ship with an overloaded organ, the condition will prove a predisposing cause to "sickness at sea," or even to the true ailment, by rendering them more liable to react when any abnormal condition of things is experienced, such as the motion of the ship if rough weather be encountered.

Those connected with the Liver we may dismiss with a word, since what has been said above of the stomach will apply equally to the liver. A sluggish liver—one which is not secreting actively—is a very bad companion for the sea-voyager, but it is not of so much importance as a predisposing cause as one

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might think from reading the advice given by some writers.

Those connected with the Nervous System are very important. Nervous fear or association of ideas will produce nausea without being on board a ship. I know of one lady who has made several voyages to India, on each occasion suffering much from sickness, who dare not venture to a dock or wharf, as on seeing the shipping violent nausea is produced. Apart from such remarkable effects as this, nervous anticipation of sickness or of danger from the sea is a potent predisposing cause. Again, persons who are generally neurasthenic, though without particular reference to the sea, are usually bad subjects; while with those who have had brain injury or are liable to epilepsy the sea will, as a rule, have an easy victory. So inconsequent a thing as a nervous headache is a predisposing cause of some importance. In fact, any condition of the nervous system which is not perfectly normal is liable to render the person under it a prey to *mal-de-mer*.

Those connected with the Ship. The ship itself is important, not only as an exciting, but also as a predisposing cause. A ship which is a bad sea boat, and takes heavy seas aboard, one in which the vibration is great, or which has a marked list, often induces sickness, when much worse weather with more actual motion on a better sea boat will not do so. This result is no doubt due to nervous influences at work, such as apprehension of danger from the noise of large quantities of water falling on the upper decks, and many other sounds which are more marked on a badly found ship than on a well-found one.

The Exciting Cause is mainly the motion of the craft on a rough sea. This motion is communicated through a special sense to the brain, and thence to the stomach as a secondarily affected organ. The exciting cause, however, is not quite so simple as it may appear at first sight. Thus we find that a pitching motion produces sickness much more quickly than a rolling one; that a person accustomed to the long, slow movements of a liner on great oceans may easily succumb to the short motion of a small ship in land-locked seas. It is found if one lies down on going aboard, or when a storm is blowing up, that sickness can often be averted; and also that if the weather becomes gradually worse passengers can generally stand it who would certainly be ill if they were subjected to a sudden storm or went straight from dry land to a boat on rough water.

It is, in my opinion, due to a complete misunderstanding of the true cause of sea-sickness that so few cases have been relieved and remedies of little or no value have been prescribed. Most people seem to have taken it for granted that, since vomiting and nausea are prominent symptoms, the disease is due to gastric disturbance. As well might it be said that vomiting in the case of a tumour of the brain is due directly to gastric trouble.

It will be well here to review the various theories put forward before taking up that which I consider to be the true cause.

There can be no doubt that symptoms of gastric disturbance are the most prominent, and, to the casual observer, or the scientific one who has not seen a great deal of this complaint, they appear to be the only ones. Those—and they are many—who hold that such symptoms are primary maintain that the motion produced by the ship creates a disturbance of the stomach and its contents, which sets up a feeling of nausea, followed in due course by vomiting. It is not clear why a particular movement should affect the mucous membrane of the stomach in this way, or why the motion of pitching should have a greater effect than that of rolling. Much confusion would be avoided if it were remembered by those who advance this theory that there are many persons whose digestive organs are weak or easily affected by any unusual condition. In these cases, no doubt, *sickness at sea* is set up, and stomachic medicines do good. To arrive at the truth the exceptional must be eliminated and the average insisted on; otherwise cases could be found to bear out apparently any, even the most extravagant, theory.

The theory that while the gastric disturbance is the primary one the brain has something to do with the origin of the sickness, but rather as a predisposing than exciting element, is held by some.

Some hold that in a sluggish liver, which reacts on the stomach, we have the true and only cause which is responsible for sea-sickness. Such a view leaves inexplicable many of the symptoms associated with the condition.

The theory of imagination is advanced to show that the primary nausea and the secondary vomiting are figments of a diseased imagination, and if persons so afflicted went on board ship determined not to be sick they would probably not suffer. This savours rather too strongly of Christian Science to be worthy of consideration.

Zing is of opinion that sea-sickness is due to a high degree of cerebral anaemia, induced by the pitching of the ship, caused by some obscure action of the vasomotor centres comparable to the mode of action of the emotions. It is doubtful if the brain is anaemic during sea-sickness; the good effects of the bromides point to the reverse. He also holds that the stomach is not directly concerned in the act of vomiting, which he considers Nature's method of replenishing the depleted cerebral circulation. The vasomotor centres are certainly disturbed, as evidenced by the flushing and subsequent chilliness experienced in sea-sickness. The disturbance I believe to be due to the emotion of fear, since this and profoun depression are symptoms of the disorder. Such disturbances are but symptoms, and by no means account for all phenomena of the condition.

There are some who hold that it is through the

sense of sight that sea-sickness is produced, the sight of the waves, the motion of the ship's masts, and other objects seen at sea being conveyed through the optic nerve to the brain. The effect of atropine on some cases is pointed out as confirmatory evidence of this theory

In considering the action of the sea upon special senses, and through them upon the brain, we are coming into the region of scientific reasoning and leaving that of empiricism. It is, however, to another special sense we must look for a true explanation. There are some cases in which the sense of sight plays an important part; but there are great difficulties in the way of accepting disturbance of this sense as the cause in all cases, or, indeed, as the true cause in any, the effect of atropine notwithstanding. The cases benefited by this drug are those in which physical fear is a prominent feature. The temporary impairment of sight by atropine—a bandage would have the same effect—calms the nervous system by preventing the patient *seeing* the motion of the water and the ship.

Thus it is a well-known fact, and one in my own experience, that a traveller will be made ill by observing the motion of a passing ship, who does not become so by feeling that of the one on which he is travelling. Nor does the optic nerve theory explain the cases, with which all are familiar, where the patient, having been asleep in fine weather, or when the ship is in dock, wakes up violently sick when the motion of a rough sea ensues.

It is to the organ which is closely allied to the sense of hearing, which has to do with equilibrium and the indication of the perpendicular position, that we must turn for a satisfactory explanation of the many phenomena of sea-sickness.

It will be well, before proceeding to indicate the way in which the effects are produced, to review briefly the anatomy and physiology of the part.

The internal ear is divided into the cochlea (or special organ of hearing), the vestibule, and the semicircular canals. It is the last that claim our attention. These canals are hollowed out of the petrous portion of the temporal bone: they are three in number, each one being placed at right angles to the other two. Each osseous canal contains a membraneous one, the lining epithelium of which secretes a fluid called *endolymph*.

The auditory nerve divides into two at the bottom of the internal auditory meatus: the anterior branch goes to the cochlea and special organ of hearing; the posterior is distributed to the semicircular canals. We have between this nerve and the vagus nerve a distinct connection by means of the facial nerve, along which impulses can be conveyed to the stomach from the semicircular canals.

In so far as the vomiting of sea-sickness is a reflex act it is possible that the sympathetic nerve has also something to do with the causation of sickness, when the terminal branches of the posterior division of the auditory nerve are irritated.

The anatomical direction of the canals themselves should be remembered—*i.e.*, two vertical and one horizontal.

The semicircular canals have two functions: (1) that directly connected with hearing, by collecting in their fluid contents sonorous undulations from the bones of the cranium; (2) that indirectly connected with the sense of hearing, by informing us as to our equilibrium, by means of the constant alterations in pressure of the fluid within the canals.

This is closely associated with coördination of muscular movements. It has been found that when the horizontal canal is divided in a pigeon a constant movement of the head from side to side occurs. When one of the vertical canals is divided, up-and-down movements are produced. These movements are associated with loss of coördination, as after the experiment the bird is unable to fly in a proper manner.

Having regard to these anatomical and physiological facts, and in view of the proofs derived from observation of the signs and symptoms of sea-sickness, there can be little doubt—

That the true cause of sea-sickness is irritation of the terminal fibres of the auditory nerve distributed to the membranous labyrinth;

That the irritation is conveyed, through the nerve connections mentioned above, to the vagus, and possibly to the sympathetic, and thence to the walls of the stomach;

That it is primarily an irritation of cranial nerves;

That this irritation is caused by the motion of a ship on rough water, but not by this alone. Any motion which is contrary to that usually experienced by the fluid contained in the semicircular canals will cause a set of symptoms exactly similar to those of sea-sickness.

Our semicircular canals constitute a sort of human spirit-level. It is not difficult to conceive that any motion which will more or less violently throw the fluid against its containing walls, richly supplied with delicate nerve-endings in direct communication with brain and stomach, will produce symptoms referable first to our equilibrium, then to the cerebrum, and finally to the stomach. This is what occurs in sea-sickness.

In searching for the true pathological cause of any condition it is a usual and proper rule to find out under what varying conditions similar symptoms are produced. Such a survey has not been accorded to sea-sickness. It was concluded that the person affected was suffering from a sort of bilious attack, produced by the unusual motion, combined, perhaps, with the smell of oil, and so on, on a steamboat. Such a lax way of viewing causation would have been condemned in any other disease, but a good-humoured laugh at the sufferer, combined with advice as to

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diet and the ordering of a couple of pills, has more or less satisfied a large proportion of the profession, if not the public. It is strange that this should be so, as the symptoms of an ordinary bilious attack are not at all similar to those of well-marked and true sea-sickness. Let us therefore try to find if similar symptoms are produced under other circumstances.

If the body be rotated rapidly, and an attempt be then made to walk, it will be found that staggering has been produced, clearly proving that coördination has been interfered with. This is owing to the endolymph having been subjected to unusual movement. Nor, if rotation be continued, is incoördination the only symptom: headache, giddiness, slight double-sight, rapid pulse, flushing followed by chilliness, and distinct nausea will in turn be experienced—these being produced by the irritated endings of the auditory nerve conveying sensation to brain and stomach. If we compare the above set of symptoms with those of sea-sickness a marked similarity is at once seen.

It is a well-known fact that some children are unable to use a swing owing to nausea, giddiness and headache being caused, while other children and many adults suffer in a minor degree. Here, again, the endolymph is subjected to an unusual motion as compared to that caused by our ordinary movements.

There are also those who experience when on a switchback railway or a water-chute one or more of the above symptoms, undoubtedly due to a similar cause.

The high dive and violent horseback exercise have been known to produce in those unused to such sports disagreeable effects of a nature akin to those of *mal-de-mer*.

In my own personal experience, and that of most other sufferers, it is the pitching motion that produces the most severe form of sea-sickness. In a rolling ship the nausea and vomiting are much less and of shorter duration. Have we in this fact any proof of the endolymph theory? Undoubtedly; since it is the fluid in the vertical canals that is affected in pitching, and, as they are two to one, we naturally suspect double the effect. In rolling, on the contrary, the fluid in two canals is practically at rest, only one—the horizontal—having its fluid level and pressure on its walls much changed.

The proportion of those who do not overcome sea-sickness, if long on board ship at one time, is small; usually, after a more or less prolonged apprenticeship, the nerve filaments become accustomed to the motion. If, however, the ocean be exchanged for the sea or channel, where the waves are short, and the liner of twelve thousand or more tons replaced by the boat of eight hundred tons, sickness in many cases will return, even in the case of old seamen.

Such a fact cannot, I think, be explained on any other hypothesis of the causation of the malady than the endolymph theory; accept that, and the explanation is easy. The fluid, which has become accustomed to one motion, is subjected to another of a different character, and the new one produces its effect. Should the circumstances be reversed and the large ship substituted for the small one, sickness will not, as a rule, be produced; since the motion of the former is better borne, the endolymph being more agitated by short seas on a small boat. A person who suffers under these conditions is not necessarily a bad ocean traveller.

Sea-sickness produced during sleep is a stumbling-block to those who believe that the optic nerve is the medium for sensation producing sickness, and is difficult to explain by any process of reasoning but the one. The endolymph is, of course, influenced by motion whether the person is awake or asleep; the effect, however, is considerably lessened by the recumbent position. Hence it is a wise precaution, advocated by many who do not grasp the true reason, for a person liable to *mal-de-mer* to lie down when starting on a short passage. Such advice is obviously not of much use to those starting on a long sea voyage, with continued bad weather, unless supplemented by treatment.

Some persons after a short voyage, on which they have experienced bad weather, continue to feel the motion after landing. This is a very direct proof of the origin of the sensations felt on board ship, the explanation being that the fluid in the canals has accustomed the nerves to the feeling of the motion, which they do not lose for some time.

It is found that, however ill a person may be, the moment the ship runs into perfectly calm water all symptoms vanish, except perhaps the sensation just referred to. Such would not be the case were the stomach seriously at fault, but is explained by the action of our "spirit-level."

It is a curious fact that, in these days of scientific accuracy, the bromides are sometimes prescribed by those who speak and write of sea-sickness being of gastric or hepatic origin. I can see only one legitimate reason for prescribing bromides—namely, belief in the nervous origin of the ailment—and I would point out, as a further proof of the pathology advanced above, the very direct effect they have in subduing symptoms.

I am not aware that such weight of practical and scientific proof can be brought forward in support of any other theory of the pathology of sea-sickness. The endolymph causation, indeed, can hardly be regarded as theory; the evidence of its being the true cause is, short of ocular demonstration, to my mind complete. Gastric symptoms are certainly prominent, but not more so than in many conditions where they are admittedly secondary. The symptoms referable to the semicircular canals and the brain are so evident that there is no mistaking them, though, to a great extent, they have been ignored in the past.

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THE SUBLIMINAL SELF.

By J. ARTHUR HILL.

I.

THERE has probably always been a suspicion, among thinkers, that we are greater than we seem to be. For one thing, the idea flatters our natural vanity—or, to put it more mercifully, our hopes and longings and aspirations—and is a hospitable refuge, giving ampler air and spaciousness in times of suffering, due to our limitations. It is expressed in many forms and places. In the Bible, mortals are referred to as "gods" (Psalm lxxxii, John x); in Christian theology the Divine and human natures are united, not in one unique instance, but in all (*e.g.*, Dante, near the end of the "Paradise" and elsewhere); in Plato's "Republic" the human soul descends from supernal realms, drinks of Lethe, and forgets its previous experience (limits itself, puts off its greatness, takes on the form of a servant); and this ***kenosis*** is closely paralleled in some of the teachings of Hinduism. The standard modern expression of the idea is that of Wordsworth in the "Ode":—

> Our birth is but a sleep and a forgetting!
> The Soul that rises with us, our life's Star,
> Hath had elsewhere its setting,
> And cometh from afar:
> Not in entire forgetfulness
> And not in utter nakedness,
> But trailing clouds of glory do we come
> From God, who is our home.

And elsewhere, in a sonnet, he finishes with the oft-quoted line: "We feel that we are greater than we know."

Until recently these ideas were left to the domain of the speculative philosopher, or poet, or prophet. But within the last quarter of a century or so they have more and more claimed the attention of the scientific man, and they have more and more obtained the support of actual, scientifically observed facts.

II.

If there is something mental or psychical in us beyond the bounds of our own minds or souls as we know them in self-consciousness, how are we to discover this something; how become aware of it? The answer cites various classes of fact, and the inferences to be drawn from them.

(1) *Subliminal Sensation.*—One small fly walking over the back of my hand arouses no sensation. It is not felt. But if there were six flies instead of one I should feel them. Thus, six times nothing produces something; or, to put it the other way, a given amount of sensation is produced by a certain stimulus, but when the latter is decreased by five-sixths the remaining sensation is not one-sixth of the original sensation, but, on the contrary, is *nil.* In other words, there is a "threshold"; below this threshold of intensity a stimulus produces no conscious sensation; but we suppose that it produces a subconscious or subliminal one. Something in us perceives the one fly, even if the normal mind does not. This is borne out by various experiments in hypnosis, whereby the subliminal can be put—as Professor James used to say—"on tap." Consciousness is like a spectrum-band. There are sensations which we do not normally become aware of, as there are rays of light which we cannot see.

(2) *Subliminal Intellection.*—For this the evidence is ample. There is no doubt whatever that something in us thinks, reasons and calculates without the normal consciousness knowing anything about it. The most striking experiments on this point are those of Dr. J. Milne Bramwell, who ordered hypnotised patients to carry out some action after their arousal from the trance—as, for example, to make a cross on a piece of paper at the end of a specified period of time, reckoning from the moment of waking. In the normal, waking state, the patient knew nothing of the order; but a subliminal mental stratum knew, and watched the time, making the patient carry out the order when it fell due. The period varied from a few minutes to several months. For instance, Dr. Bramwell would say to the hypnotised patient: "You will feel impelled to make a cross on a piece of paper, and will do so, putting down the time also. This is to take place at the expiration of 24 hours and 2,880 minutes." This is one of the actual cases: the order was given at 3.45 p.m. on Saturday, December 18th, and it was carried out correctly at 3.45 p.m., December 21st. In other experiments the periods given were 4,417, 8,650, 8,680, 8,700, 11,470, 10,070 minutes. All were carried out correctly. In the waking state the patient was quite incapable—as most of us would be—of calculating mentally when these times would elapse. But the hypnotic stratum could do it, and could ensure that the order should be carried out at the exact moment of falling due. In one instance the time happened to expire during the night. The patient made the cross on paper at her bedside at the correct time, apparently without waking, for she had no recollection of having done it.*

We may say, then, that not only is there some subliminal part of our minds that can calculate, but also that this something can calculate better than the ordinary waking consciousness.

The same conclusion is arrived at by consideration of the performances of "arithmetical prodigies." It

* *Proceedings, Society for Psychical Research*, XII., p. 185.

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is often found that these curiously endowed people can solve in a few seconds—and sometimes almost instantaneously — problems which would utterly baffle most ordinarily educated people, and which would take an average arithmetician a quarter of an hour's rapid work with pencil and paper. Yet these prodigies—who, by the way, are often, like Dase, Buxton and Mondeux, of very low mental power so far as their normal faculties are concerned—are entirely unable to tell how they do it. They do not consciously work the sum out. They let it sink into their minds and then wait for the answer to be shot up. It is like putting the plum-pudding into the geyser to be boiled; or like putting the pig into the Chicago machine. It goes in pig and comes out sausages. The intermediate processes are hidden from us. The calculation is made subliminally — below the threshold of ordinary consciousness.

Subliminal Memory. — The results of hypnotic experiment and of the study of pathological cases of split personality (such as Dr. Morton Prince's Miss Beauchamp) are sufficient to prove beyond question that the subliminal memory is wider than the normal one. Many things which we "forget" seem to slip down below the threshold, thus becoming lost to ordinary consciousness, but remaining accessible by hypnotic methods. Or it sometimes happens that they are recovered in sleep, when the conscious self is in abeyance, and the other strata of the mind come to the top. Or they turn up in automatic writing with planchette or a pencil. In a recent striking case, reported to the Society for Psychical Research, an automatic writer had communications from a "spirit," who called herself Blanche Poynings, and gave a great deal of historical detail which the automatist did not consciously know. But it was afterwards found that Blanche Poynings was a character in a novel which the automatist had had read to her many years before, and the novel contained all the historical details given. All this had been "forgotten." It had slipped down below the threshold. But the subliminal strata still retained it and could produce it (in the usual mystifying spirit style) when tapped by a borehole, sunk, so to speak, through the upper level of consciousness, by means of automatic writing.

Subliminal Emotion.—This is a reality also, though perhaps less provable. An interesting example of the necessary evidence occurred in Mrs. Verrall's experience with automatic writing some time ago. [Mrs. Verrall is a classical lecturer at Cambridge; translator of "Pausanias"; widow of Dr. A. W. Verrall, late King Edward Seventh Professor of English Literature.] This automatist, without experiencing conscious emotion, found the tears running down her face when she roused herself from a semi-conscious state in which she had been writing automatically. The script, on examination, turned out to contain references to two friends who had died under tragic circumstances; but Mrs. Verrall was quite unaware of the contents of the script until she had read it. Evidently some part of the mind was not only thinking and remembering and making the fingers write without conscious direction, but was also feeling and suffering, and making the eyes overflow without the conscious mind knowing why. (*Proceedings S.P.R.*, XX., p. 15.)

Subliminal Creation.—This is the best proved of all, for most of us prove it for ourselves every night. In dreams every one of us becomes novelist or dramatist, inventing situations—usually absurd to the waking mind—which are absolutely novel in our experience. And, to step at once to the higher plane, it can be said, without fear of contradiction, that all works of genius, all creations, are uprushes from subliminal depths. They are not produced by taking thought. The process is felt to be quite different from that of the faculty which thinks and reasons consciously. It is more a waiting than a working. "All is as if *given*," said Goethe. (*Alles ist als wie geschenkt.*) The inspiration comes from below the threshold. Many great writers amply bear out Goethe's dictum. Ibsen wrote "Brand" in three weeks in a state of feverish exaltation, scrambling out of bed to write down, half asleep, the lines which rose tumultuously to the surface of his mind. Charlotte Brontë could write freely on some days, while at other times the story hung fire for weeks at a time, refusing to unroll itself; then a volcanic burst, and she would write furiously until she was ill with the strain. In her preface to Emily's "Wuthering Heights," discussing the rightness of creating such characters as Heathcliff, she states the case in unsurpassed language:—

"But this I know; the writer who possesses the creative gift owns something of which he is not always master—something that, at times, strangely wills and works for itself. He may lay down rules and devise principles, and to rules and principles it will perhaps for years lie in subjection; and then, haply without any warning of revolt, there comes a time when it will no longer consent to 'harrow the valleys, or be bound with a band in the furrow'—when it 'laughs at the multitude of the city, and regards not the crying of the driver'—when, refusing absolutely to make ropes out of sea-sand any longer, it sets to work on statue-hewing, and you have a Pluto or a Jove, a Tisiphone or a Psyche, a Mermaid or a Madonna, as Fate or Inspiration direct. Be the work grim or glorious, dread or divine, you have little choice left but quiescent adoption. As for you—the nominal artist—your share in it has been to work passively under dictates you neither delivered nor could question—that would not be uttered at your prayer, nor suppressed nor changed at your caprice. If the result be attractive, the World will praise you, who little deserve praise; if it be repulsive, the same World will blame you, who almost as little deserve blame."

This would be endorsed by Scott, who dictated "The Bride of Lammermoor" while ill and in an abnormal mental state, and found a great part of the story quite new to him when he read it in the book. Also by Stevenson, who tells us that he wrote fifteen chapters of "Treasure Island" in fifteen days, then stuck completely; "my mouth was empty; there was not one word of 'Treasure Island' in my bosom"; but again the tide rose, "and

behold! it flowed from me like small talk," and he finished it at the rate of a chapter a day. It is interesting to remember, in this connection, that Stevenson used to *dream* most of his plots, as he describes in "Across the Plains."

Similar statements of experience could be culled from other fields of creative art. Perhaps it is even more marked in music than in literature Mozart, for example, had a vivid perception of the extraneous nature of the afflatus—extraneous, that is, to the conscious mind; and, among painters, Watteau frankly and quaintly avows himself puzzled at the "queer trick he possesses," evidently not knowing in the least how he did it. Indeed, no genius *does* know "how he does it." If he knew, he could teach others to do it also. No, it is not the knowing part of the mind that is the agent, nor is it any part that the consciousness can understand. The power lies deep buried in the subliminal levels. It is only its results—its exfoliations—that we see.

It is established, then, that there can be mental or psychic activity of many kinds—sensational, intellectual, reminiscent, emotional, creative—over and above anything that the conscious mind is aware of. Science has proved that we are greater than we knew. The hinter horizons of the mind have receded and fled away. New vistas open out in metaphysical psychology. The soul is become immense, immeasurable. We are suddenly transplanted from a cellar dwelling to the illimitable prairie. Not only do we not know what we shall be, but we do not even know what we are. Like Malvolio, therefore, we may again "think nobly of the soul." The Psalmist, quoted approvingly by Jesus, said: "Ye are gods." A blinding and stunning thought! But, whether we go so far as that or not—and, after all, it is not a very great thing to say, for we are certainly more wonderful creatures than many of the Greek and Norse gods—we can at least subscribe to that profoundly wise and suggestive triplet of Emerson's, who in so many of these things had a curiously prophetic instinct:—

> Draw, if thou canst, the mystic line,
> Severing rightly his from thine,
> Which is human, which divine.

III.

The late Professor William James used to say that he thought the most fundamental problem in philosophy was that of the One and the Many. How can a Universe which is Whole and One, containing everything that is, both material and immaterial—how can this One Thing be at the same time Many? And if we start with the manyness, this and that tree and house and mountain and country, this and that microbe, blade of grass, butterfly, how are we ever going to visualise them as one, when they are so incontestably disparate? The problem is at present insoluble. We can begin at either end, but there is no meeting-place in the middle. One remains One, and Many remains Many.

But in the region of mind or soul the modern doctrine of the subliminal self—which, first propounded by Myers twenty-five years ago, was afterwards hailed by James as the greatest modern advance in psychology, and which is continually being buttressed by new facts—is at least pointing to a kind of solution to this problem. Human minds are many, it is true; but they are closely alike, and in all biological science it is found that close similarity points to a common source. In some sort, then, it is to be surmised that all human minds descend from a common source. But the phenomena of psychical research—telepathy, to name only one—indicate that there is absolute *connection* between the minds here and now existing, in ways over and beyond those accounted for by the known senses. And there is reason to believe, though the evidence is too complex to specify here, that in telepathy and allied phenomena it is the subliminal part of the mind that is active. These and other considerations point to the supposition that though our ordinary normal consciousnesses are severed from each other, and apparently distinct, so that we have to communicate with each other by the clumsy means of speech and writing, we are nevertheless all in connection with each other in the subliminal levels. To vary the metaphor, each of us is like a stream of water issuing from one of the thousands of taps in a city, but the water is the same, coming from the same reservoir. The same soul thinks in all of us. The One *is* the Many.

It may be said that this conclusion is a speculative and abstract proposition. On the contrary, it is extremely practical; for it has close connection with human action. Remember how we feel about our brothers and sisters; how we stand shoulder to shoulder with them, feeling that the interest of the family is a common interest, for which each individual is bound to fight. Remember also how, broadly speaking, the individual's welfare is bound up with that of the family, and what is good for it, is also good for its component units. And now think what would happen if all men, or even all civilised and educated men, could regard humanity at large as one huge family, one in interest and, further, one in reality and essence, being joined together in that subliminal region, the individual separation of the conscious minds being illusion, due to ignorance of our real nature. Would not a revolution be effected? I am sure it would. And, sooner or later, it will. The religious doctrine of the brotherhood of man was a noble moral inspiration but its appeal was to the affective side, and it was consequently inoperative against the coldly intellectual. But it is now supported by science. Knowledge now goes hand in hand with faith and love. A new dawn begins to send up its shafts of light in the East. A new era is at hand.

According to present conventions, it is bad form to be in earnest about anything; the proper thing is to cultivate a manner of light banter which shall give an impression of cleverness and wit. The

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popularity of the fashion is very comprehensible; for there are always plenty of people who wish to seem clever but are not. And the trick of it is easily acquired. Be cynical and flippant about everything, and you will get the credit of having seen through the illusions of the world, and of being a deeply wise man who conceals his wisdom. But it is a pose and an affectation. There is really no disgrace about being serious, at least occasionally, nor in being honest, even almost habitually! If I seem too solemn or too enthusiastic in my vision of the future when the unity of mankind shall be more fully realised, I appeal from the decadent trifler of to-day to the vigorous thinker of to-morrow—from Philip drunk with sophistication and selfishness to Philip sober with clear eyes and better ideals. Better times are coming. We are beginning to see that we are not a "concourse of warring atoms," but a vast multitude of units which fit together and make up an organism; and that what is good or bad for the organism is good or bad for the units. Solidarity and homogeneousness are the watchwords. Individualism has been over-accentuated. We must see humanity steadily, and see it whole—a whole, however, within a still larger Whole of the entire Cosmos.

SOLAR DISTURBANCES DURING MAY, 1913.

By FRANK C. DENNETT.

MAY has been remarkable for the small amount of disturbance upon the Sun. The disc has been examined every day, but on twelve occasions (1, 3, 6, 8, 12, 13, 19, 20, 22, 23, 29, and 31) it has appeared to be quite free from disturbance, bright or dark. Short-lived pores were noted on three (11, 16, and 25), and faculae on the remaining sixteen. The longitude of the central meridian at noon on May 1st was 224° 27′.

On May 1st and 2nd the granulation of the photosphere was noted as being very fine all over the disc. On the 11th there appeared to be very many minute pores in the central portion of the disc and in northern latitudes. One showed as a small irregular umbra near the central meridian (94°) with large faculic flecks about it.

On the 16th, in the afternoon, pores showed in high latitudes both north and south, well to the west of the central meridian, which was 24°.

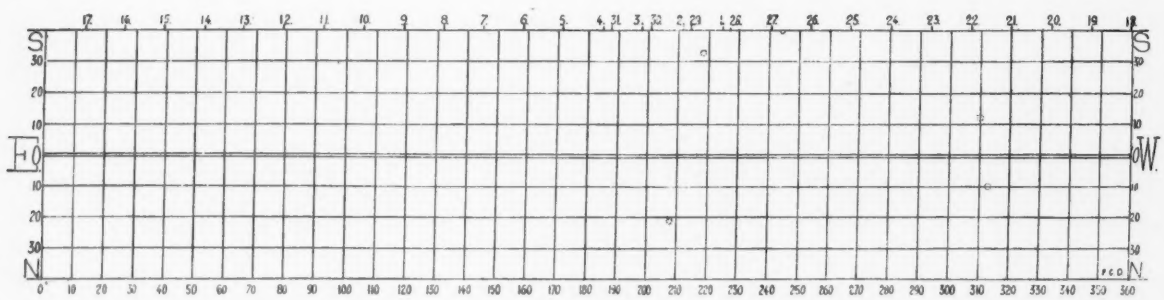
On the 25th, at 5.15 p.m., in high latitude south-east, about six days on the disc a small pore showed in a rough-looking area, nearing the central meridian, which was 264° 13′. Unfortunately no measures were made in either of these cases.

The faculic display was also of a most meagre description. On the 4th and 5th a faculic cloud was measured at longitude 244°, south latitude 40°. On the 14th and 15th a small bright facula was situated at 339°, 68° South; on the 16th and 17th a small facula at 312°, 10° North, and on the 17th, a paler one at 310°, 12° South; on the 24th a pale one at 218°, 33° South, and another at 208°, 21° North. Perhaps the most interesting one was a brilliant granule, less than 7° from the South Pole, seen on the 26th, 27th, 30th, and June 4th.

Other faculae were seen, but not measured, near the western limb on the 21st and 28th; south-western on the 7th, 10th, 17th, 18th, and 30th; south-eastern on the 10th, 14th, 15th, 17th, and 25th; and north-eastern on the 2nd, 9th, and 10th.

The Chart was constructed from the observations of Messrs. John McHarg, A. A. Buss, C. Frooms, E. E. Peacock, and the writer.

DAY OF MAY, 1913.



THE MOON.

THE plate of the Moon given in Figure 267, on page 261, shows much fine detail, particularly in the Maria Imbrium, Nubium and Crisium; Tycho, Copernicus, Kepler and Aristarchus are very well defined. From the sketch-maps published in "KNOWLEDGE" during 1909 all the points to be seen in this plate may be identified. The image is shown as it would appear in an inverting telescope. The photograph was taken at Paris on November 13th, 1902, at 2.57 a.m., with the Equatorial Coudé. The aperture was 23·62-ins., the focal length 59′ 6″·6, and the exposure 0·6 of a second.

From a photograph by P. Puiseux.

FIGURE 267. The Moon. Age thirteen days five and a half hours.

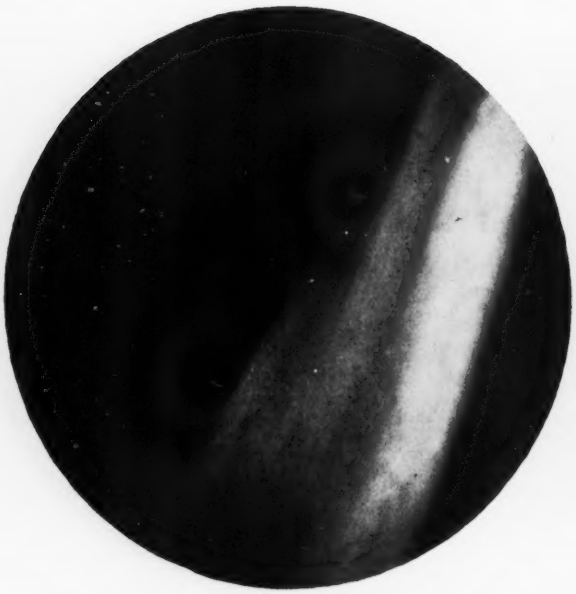


FIGURE 268.
Photographed from Store Korsnes.

FIGURE 269.
Photographed from Bossekop.

Aurora Band across the Great Bear, March 29th, 1913, $10^h\ 15^m$.

From a photograph *by E. E. Barnard.*

FIGURE 270. Nebula ρ Ophiuchi.

Taken at the Mount Wilson Observatory April 5th, 1905, with an exposure of $4^h\ 30^m$.
Position of the Nebula R.A. $16^h\ 20^m$. Declination $-23°$.

ON AN AURORAL EXPEDITION TO BOSSEKOP IN THE SPRING OF 1913.

By PROFESSOR CARL STÖRMER,

(*University of Christiania*).

THE following is a short account of a new auroral expedition which I made to Bossekop in the spring of 1913 for the purpose of completing the results of my expedition to the same place in 1910.*

My assistant was the meteorologist, Bernt Johannes Birkeland, who also went with me in 1910, and is going with Roald Amundsen's expedition over the North Polar basin.

The purpose of the expedition was mainly to obtain more accurate and a greater number of auroral photographs for the determination of the form of aurora and its height and situation in space, and, further, to experiment with prism-objective photographing and the taking of cinematograph films.

Our preparations and equipment were, on the whole, the same as in 1910; but the following improvements, based upon experience gained on that expedition, were carried out.

The cameras were furnished with an arrangement whereby a photograph of an illuminated watch-face was taken on the plate simultaneously with the aurora. The time could then be read from the photograph, and also the exposure by the sector described by the second hand. This improvement I had already employed in photographing aurora in Christiania in the winter of 1910–11.

In order to avoid the waste of time in changing plates in a dark room, each station, in addition to forty cassettes, was furnished with changing boxes in which the plates could be changed in the open air. Thanks to this improvement, it was possible on some evenings to take more than eighty simultaneous photographs at the two stations.

In order to have the arms at liberty the following improvement in the telephone arrangement was made. The microphone and receiver were fixed to the chest and head and connected with the field telephone apparatus by a cord four metres in length. In this way it became possible to utilise more fully the brief moments during which the aurora displayed its greatest intensity.

For the purpose of obtaining reliable parallaxes a base of twenty-seven and a half kilometres was chosen, as against four and a half kilometres in 1910. The station at which Birkeland took up his quarters was Store Korsnes, the other was Bossekop. As assistant at Bossekop I had engaged Sergeant Ottem. The direction from Bossekop to Korsnes was almost due north.

Through the courtesy of the Telegraph Department the State telephone line from Bossekop to Korsnes was placed at our disposal every night from 7.30 p.m.

Thanks to these arrangements, we succeeded in one month in taking the following pairs of simultaneous auroral photographs at Bossekop and Korsnes :—

Day.	Number of Pairs taken.	Of these Successful.
Feb. 28...	14	0
Mar. 3...	38	19
„ 4...	23	9
„ 6...	7	1
„ 11...	86	58
„ 14...	81	54
„ 15...	81	72
„ 16...	8	2
„ 17...	14	7
„ 18...	5	5
„ 21...	23	20
„ 22...	20	12
„ 23...	1	1
„ 24...	6	6
„ 28...	5	3
„ 29...	83	64
„ 30...	71	62
April 1...	70	52
Total	636	447

On the six best evenings, the 11th, 14th, 15th, 29th, and 30th March and 1st April, the weather was clear and the aurora vivid and continuous, so that we were able to make use of every chance.

The parallaxes, thanks to the large base, were very distinct, as a rule between five and fifteen degrees, and the large number of photographs—four hundred and forty-seven pairs as against forty-four in 1910—gives very much more certain and complete results than on that occasion. If we reckon about ten measurements to each photograph, these will give more than four thousand reliable determinations of height. All important forms of aurora were photographed, and there are long series of developments.

*See *Bericht über eine Expedition nach Bossekop zwecks photographische Aufnahmen und Höhenmessungen von Nordlichtern*, mit 57 Figuren im Text und 88 Tafeln. Videnskabsselskabets Skrifter, Math-Naturv. Klasse 1911, No. 17, Christiania.

A pair of the photographs are reproduced in Figures 268 and 269 enlarged about two and a quarter times, one degree answering to two millimetres in the photographs. The time is Central European time and reckoned from 0^h to 24^h, 0^h answering to 12 noon.

With a prism-objective we succeeded in taking some photographs simultaneously with the auroral photographs, on which are seen stellar spectra and some views of the aurora lying side by side, answering to various spectral lines. The prism had an angle of 60°† and was placed in front of the kinostigmatic objective, on the principle already mentioned in my "Bericht." A systematic employment of this method will be of great importance to the study of the highest strata of the atmosphere.

Most of the cinematograph attempts were failures, as the film (Lumière) was not as a rule affected by an exposure of less than two seconds. It was only with very intense aurora that we succeeded in getting good photographs with an exposure of about one second and with about two seconds' interval between the photographs. Two or three such series were taken, thus proving the utility of the cinematograph both for taking photographs and for registering rapid changes.

The working-up of the matter collected during the expedition will be the subject of a subsequent detailed account.

† With regard to the kind of glass that would be best for the purpose. I received valuable information from Dr. Slipher when visiting the Flagstaff Observatory in the summer of 1912.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

PROLONGED OBSERVATIONS OF TEMPORARY STARS.—Professor Barnard has put the Yerkes 40-inch refractor to a very useful piece of work in following the temporary stars of recent years long after they have become invisible to ordinary telescopes. He notes that in at least two cases—T Coronae of 1866 and Nova Geminorum (2) of 1912—the Nova was identical with a previously seen or photographed star. His study was made partly in the hope that he might find some peculiarity in the aspect of faded Novae. In this he was disappointed: a few of them show longer focus than ordinary stars, and the more recent ones show slight variability, but otherwise they are indistinguishable from ordinary stars. T Coronae was a B.D. star of magnitude 9·5 before the outburst, and is now at practically the same magnitude and apparently colourless.

Nova Cygni of 1876 is now of magnitude 15, perhaps slightly variable: its appearance is hazy and the focus longer than usual. In these respects it resembles Nova Aurigae of 1891, which is a magnitude brighter, and Nova Sagittarii of 1898, which is of magnitude 15.

Nova Persei of 1901 is now of magnitude $12\frac{1}{2}$, well defined and colourless, of ordinary focus. According to Professor E. C. Pickering this star existed before the outburst as a star, photographed as far back as 1890, whose light fluctuated between magnitudes 13 and 14.

Nova Lacertae of 1910 also existed before the outbreak as a star of magnitude $13\frac{1}{2}$; it is now of magnitude $12\frac{1}{2}$, having the appearance of a small bluish-white nebula; focus five millimetres greater than usual.

Nova Geminorum of 1912 existed before the outbreak as a 13·5 magnitude star. It fluctuated in brightness last winter, and was of magnitude $8\frac{1}{2}$ last January. On February 8th, 1913, "with good seeing and at the proper focus, the Hα image was clearly seen. It was small, sharp, and intensely crimson, surrounded by a greenish-blue halo 3″ or 4″ in diameter. The normal focus, however, was not different from that of an ordinary star."

Nova Geminorum of 1903 is now of magnitude $16\frac{1}{2}$ and still fading. The Nova of the Andromeda nebula (1885) is now invisible; this may be partly from the bright background.

Professor Barnard also gives a diagram of the small stars in the region of Tycho's Cassiopeia Nova of 1572. There are several stars shown, but none of them appeared in any way peculiar.

SATURN'S NINTH SATELLITE.—Another interesting paper of Professor Barnard's describes his visual observations of Phoebe with the 40-inch. Now that Saturn is far north of the Equator he finds the satellite quite an easy object, at least as bright as magnitude 14 (it had previously been supposed to be of magnitude 16). The positions were in practically perfect agreement with the American ephemeris, which uses Dr. F. E. Ross's elements. As these were prepared several years ago, and as the perturbations are very large, this agreement is most creditable to him.

PARALLAX OF THE ANDROMEDA NEBULA.—*Astr. Nachr.* No. 4650 contains a determination of the parallax of one of the small companion nebulae of the great one, made by M. Gustaf Strömberg at Stockholm. He obtains for the parallax 0″·073 with a probable error of 0″·055. Some previous determinations had given 0″·171, 0″·132, and 0″·070 for the parallax. As the nebula is a difficult object for precise measurement it can only be claimed that the results give some slight probability to the conclusion that it has a sensible parallax, which of course if proved would negative the idea of its being an external universe.

THE STAR POLARISSIMA.—*Astr. Nachr.* No. 4650 has an article by L. Courvoisier on this faint star, which is of magnitude 9·3. It is only 10′ from the North Pole, and thus is always within the range of the field of view of a meridian instrument; also it is bright enough to observe on a clear night with a partially illuminated field, so the writer suggests that it might with advantage be used for obtaining the azimuth error of the instrument. For this purpose an accurate knowledge of its place and proper motion is required. These are investigated in the article. The proper motion is given as about 3″ per century with a probable error of one-third of itself. The star's right ascension this year is $14^h\ 12^m$, diminishing 5^m each year.

VARIATION IN THE SUN'S RADIATION.—*Astr. Nachr.* No. 4656 contains a paper by Messrs. Abbot, Fowle and Aldrich on the simultaneous measures of the Sun's radiation at Mt. Wilson and at Bassour, Algeria. The mean value after correcting for atmospheric absorption, and so on, is 1·929 calories per square centimetre per minute. It appears to increase 0·07 calorie for an increase of 100 in Wolfer's sun-spot numbers. There is also an irregular variation of 11 per cent. which is concluded to be really in the Sun, from

the fact that the two very distant stations agree in the days that give unusually high or low values.

High radiation values are accompanied by a relative increase in the strength of the violet radiations, and consequently increased contrast between the centre and edge of the Sun's disc. From this they conclude that the variation is actually in the Sun, and not due to the interposition of a meteoric screen. Haze was very prevalent in 1912: it is supposed to have been caused by the presence of fine dust in the air, from the eruption of Mt. Katmai in Alaska. When this is allowed for, the radiation of 1912 is higher than that of 1911. Hence the cause of the abnormally hot summer of 1911 is to be sought on the Earth, not in the Sun; but the Katmai dust may have had something to do with the cold summer of 1912.

BELTS ON NEPTUNE.—The same number contains a series of drawings of Neptune made by Professor T. J. J. See in 1899. They clearly show a number of curved dark belts on each side of the Equator, where there is a narrow bright streak. These drawings were made before the position of the Equator had been deduced from the shift of the node of the satellite's orbit, and it is interesting to note that the Equator in the drawings is not in the plane of the satellite's orbit, but inclined to it about 20°, which agrees with theory. Belts on Uranus were seen by Mr. Buffham, Professors Young and Schiaparelli and the Henry brothers. The four giant planets seem to be all alike in this respect, as in low density and rapid rotation.

THE SELENIUM PHOTOMETER.—A posthumous paper by Professor Ristenpart describes an application of the selenium photometer to the measurement of the diminution of light in the solar eclipse of last October. The time of minimum light is very sharply defined, the curve on each side being very steep; while this particular research is more ornamental than useful, it illustrates the power of the method, which depends on the increased electrical conductivity of selenium when light falls upon it.

SCHAUMASSE'S COMET.—The following are improved elements of this comet:—

Perihelion passage, 1913. May 15·1648, Paris M.T., Omega 53° 2′ 17″, Node 315° 5′ 25″, Inclination 152° 21′ 23″, Log Perihelion Distance 0·163514.

Ephemeris for midnight, July 3, R.A. $13^h\,0^m\,12^s$, N.Dec. 28° 34′; July 7, R.A. $12^h\,52^m\,7^s$, N.Dec. 26° 56′; July 11, R.A. $12^h\,45^m\,50^s$, N.Dec. 25° 29′; July 15, R.A. $12^h\,41^m\,0^s$, N.Dec. 24° 11′.

NAMES FOR THE units of planetary and stellar distances are suggested by Mr. J. W. Scholes. He gives Parxsecarc for the stellar unit. This is like the "Parsec" suggested by Professor Turner. "Disethsun" is suggested for the distance Earth-Sun; for myself I should have thought the term "Astron" very suitable for this, if not used for the stellar unit. For it is an obvious abbreviation of Astronomical unit of length, which has hitherto been the term used.

CONGRATULATIONS to Sir J. D. McClure on his knighthood. There must be many of our readers who have heard his lectures on astronomy, which were prepared with the most conscientious care and zeal for accuracy, and whose illustrations, both pictorial and verbal, were calculated to arrest and sustain the interest of his hearers.

OBITUARY.—I have heard with regret of the death of Mr. F. W. Henkel, who was a familiar figure at astronomical meetings and an occasional contributor to this magazine. Also of Professor Luis G. León, the energetic Secretary of the Mexican Astronomical Society. He made its journal a most readable summary of astronomical progress; he visited Greenwich a few months ago, and published an interesting account of his impressions.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

ANTARCTIC LICHENS.—In his report on the lichens of the Swedish Antarctic Expedition (*Wiss. Ergebn. Schwed. Südpolar-Exped.*, Band 4, 1912) Dr. Darbishire gives some interesting details regarding the distribution of lichens generally in the Antarctic and Arctic regions. Up to the present one hundred and five lichen species are known from the land lying strictly within the Antarctic limits, and of these thirty-two occur also in sub-Antarctic America, twenty-five in New Zealand, and sixteen in South Georgia, showing a very close affinity between the Antarctic lichen flora on the one hand and the American and New Zealand lichen floras on the other, the difference to the disadvantage of the latter being accounted for by the greater nearness of the sub-Antarctic American region to the extreme limit of the southern drifting pack-ice. The lichens of sub-Antarctic America and New Zealand are also very closely allied; for out of the one hundred and thirty-three lichen species of the former flora, one hundred and thirteen are found in New Zealand, thirty-two in the Antarctic, and thirty-one in South Georgia, the latter being evidently, from the phytogeographic point of view, a half-way house on the road from sub-Antarctic America to the Antarctic area. Moreover, about half of the Antarctic species occur also in the Arctic regions.

Of the one hundred and six Antarctic lichens, sixty-nine are crustose (encrusting forms which are applied so closely to the rock that the latter has to be chipped off in order to get specimens of the lichen), eighteen foliose (attached to the surface at various points on the underside of the thallus, but more easily removed than the crustose forms), and nineteen fruticose or shrub-like (attached only at one point): of these, the numbers found in sub-Antarctic America are respectively sixteen, five, and eleven. Of the sixty-seven species found only in the true Antarctic area and nowhere else, forty-nine are crustose, ten foliose, and 8 fruticose. The sub-Antarctic American flora includes three hundred and six lichen species, while seven hundred and forty have been found in New Zealand: of the species common to the two regions fifty per cent. are fruticose, thirty per cent. foliose, and only twenty per cent. crustose. The affinities of the lichen floras of sub-Antarctic South America and New Zealand lie mainly in the fruticose lichens which are the oldest and probably the least variable forms. The encrusting lichens are more variable and have adapted themselves more readily to local conditions, thus giving rise to new species.

Dr. Darbishire raises the interesting question of the resistance to cold by lichens, and suggests some experiments which might be made on these plants in the coldest regions. For instance, it would be interesting to determine the amount of water contained in the lichen thallus at different times and seasons; in what condition the lichens exist during the long winter; at what temperature assimilation begins, and so on. It is of little use to make experiments on the plants in warmer climates if we wish to ascertain how these lichens can live under the adverse conditions prevailing in the polar regions. Lichens are found everywhere on the outer limits of vegetation, and their chief ecological factor is their power to become quite dry and yet remain alive. No doubt it is this power which enables them to spread slowly but surely into the bleakest and most inhospitable regions. They are making their way towards the North and South Poles, and so far have been beaten in their race only by the perpetual covering of snow. If bare rocks are found in the neighbourhood of the Poles themselves there is little doubt that lichens will be found growing there.

VEGETATION OF NATAL.—An extremely interesting account of the vegetation of Natal is given by Professor J. W. Bews in the *Annals of the Natal Museum*, II, 1912. From the coast to the Drakensberg range, Natal presents three terraces (about three hundred, six hundred and one

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thousand metres respectively) with a mountain range above one thousand five hundred metres. The chief rivers cut back deeply into the higher topography, hence, in addition to the main terrace system there is a system of river valleys at a low level, and intervening ridges at a high level, introducing greater complexity into the conditions affecting plant-life. The soils are generally derived from poor shales and sandstones, but locally enriched by the frequent occurrence of intrusive basic igneous rocks. A table of soil analyses is given. Natal is a region of summer rainfall, and the higher hills are moister than the valleys; the rain clouds from the Indian Ocean deposit first on the coastal belt, and the rising edge of each successive terrace receives more precipitation than the intervening terrace-plateaux; mists also contribute largely to the water-supply of the plants. Extensive meteorological tables are given in support of the author's conclusions on the distribution of the vegetation in relation to climatic factors—rainfall and temperature at different periods of the year. There are great variations in illumination, from the low intensity of the bush formation to the full light of the open veld; details are given for various habitats. Interesting details are given as to the influence upon the vegetation of winds, fires, and animals (termites, locusts, caterpillars, earthworms, mammals) and man; the effect of termites ("white ants") on the soil through their tunnelling and nest-building is more than equalled by their direct effect on the vegetation through their fungus-gardening and general scavengering operations. The plant formations and associations are described and illustrated by excellent photographs, with lists of species classified to indicate dominance and biological grouping. The shore vegetation comprises (1) halophilous associations on unstable sand, including *Scaevola* and *Cyperus*, *Ipomaea Pescaprae*, and *Mesembryanthemum* associations; (2) psammophilous bush formation on fixed dunes fifteen to seventy metres high, forming a fringing belt along the whole coast of Natal, as much as fifty miles broad in Zululand, and consisting of trees with little undergrowth but many lianes; (3) lagoon mangrove formation, an interesting outlier of the Eastern mangrove flora with *Avicennia officinalis*, *Rhizophora mucronata*, and *Bruguiera gymnorhiza*, at the river estuaries where the sand-dune bush is interrupted with a *Salicornia herbacea* association on mud-flats; (4) a *Barringtonia* association just above the lagoons in wet ground more sandy in nature and not brackish.

The inland vegetation consists of evergreen dicotylous forest and grassland with summer rains and dry winters; the lower valleys have a dry climate, low winter temperature, and a xerophytic vegetation. The forest is divided into (1) coastal bush extending up to the edge of the first terrace, about five hundred metres, on south-eastern slopes facing the rain-clouds and sheltered from dry hot winds, with species which mostly extend through tropical East Africa—*Albizzia fastigiata* and *Rhus longifolia* dominant; (2) midland bush, also on the south-eastern slopes and receiving the largest rainfall in the region—vegetation in general similar to that of the coastal bush, but with *Combretum* and *Calodendron* dominant; (3) yellow wood bush, forming the larger forest areas of Natal, at one thousand metres and above, with *Podocarpus* spp. and *Olea* dominant; (4) rocky stream flora of the narrower valleys, chiefly differing from the other three types in the undergrowth which includes a rich and varied cryptogamic flora—from its more variable and indefinite character it apparently represents a migratory type in contrast to these three types, which represent the formation on stable topography; (5) thorn veld or thorn savannah, including the vegetation of the broader dry valleys, with trees (*Acacia* spp., and so on) scattered through the veld grassland.

The veld or grassland (grass savannah), widely distributed in Natal, presents two types:—(1) high veld on the open soils of the higher hills with the larger rainfall, with tall grasses which flower regularly, *Anthistiria imberbis* usually dominant and associated with *Andropogon* spp., *Digitaria*, and so on; (2) low veld on hard dry clays with valley frosts and low rainfall, with more xerophytic grasses (low-growing, more hairy), *Anthistiria* dominant but tufted and seldom flowering. Associated with the veld grasses are numerous herbs, some of which always flower immediately after the burning of the grass; the majority (including numerous bulbous monocotyledons) flower early in the season soon after the first rains and before the grass has grown tall enough to shade them; and a third class includes taller forms that grow with the grass and flower late. In marshes on wetter parts of the veld the dominant plants are grasses and sedges; actual lakes are rare, and often contain surprisingly few aquatic phanerogams, and most of the marshes are dried up more or less completely in the dry season.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

THE FUTURE OF MOTOR SPIRIT.—The problem of the future supply of motor spirit is discussed by Professor V. B. Lewes in *The Chemical World* (1913, II, 111). The trade statistics show that during the last seven years the imports of petrol into Great Britain have risen from eighteen million to eighty million gallons, whereas the increase in the world's output of crude petroleum oil has only been from 28·5 to fifty million tons. Most of the petrol imported into this country has been derived from America and the Dutch East Indies, but the increase in the demand in America has reduced the supply available for export and has raised the price of the crude oil.

Various methods are now being used to obtain a larger yield of petrol from the crude oil. The gas escaping from the wells in the oil-fields is collected and compressed, and the light spirit thus obtained is mixed with the light fractions of higher boiling-point separated in the distillation of the oil. The specific gravity of the petrol used for motors is now 0·720, as compared with 0·680 when a larger supply of the light fractions was available.

Methods have been devised whereby heavier fractions of crude oils are converted into lighter products, such as, for example, distillation in the presence of a catalytic agent like nickel, or superheating the vapours while in process of distillation.

In one American process a heavy petroleum fraction, termed "solar oil," is sprayed together with water into an iron retort packed with iron filings and heated to 600° C. The vapours issuing from the retort are fractionally condensed, and yield about thirty-nine per cent. of petrol, thirteen per cent. of solvent spirit, and thirteen per cent. of varnish.

Professor Lewes points out, however, that crude petroleum oil cannot be regarded as a lasting source of supply, and in his opinion the motor spirit of the future will probably consist of alcohol containing about ten per cent. of benzol.

At the present time about eight million gallons of benzol are recovered in coke-oven plants, while the Scotch shale industry produces each year about six hundred thousand gallons of motor spirit.

A NEW IRON BACTERIUM.—A bacillus that has a specific action upon solutions containing iron has been isolated by Mr. E. M. Mumford (*Chem. Soc. Proc.*, 1913, XXIX, 79), from the Bridgwater Canal tunnels at Worsley, Lancashire. This bacillus varies in its actions upon iron solution according as to whether it acts in the presence or absence of air. Under aërobic conditions the iron, whatever its condition of oxidation, is precipitated as ferric hydroxide, while under anaërobic conditions no precipitation of dissolved iron takes place, although any ferric hydroxide already precipitated is dehydrated and reduced to bog-ore. It is probable that in nature these two actions take place simultaneously, and account for the deposits of bog-ore found in various places.

The bacillus is a short organism about two microns in length. It is motile and forms different involution forms. It can be cultivated upon ordinary culture media and grows readily upon potato, on which it forms greenish-brown nodules.

An enzyme has been separated from the bacillus, and this also has the same specific action upon iron, its optimum temperature of activity being 70° C. Both the bacillus and its enzyme require the presence of nitrogen in the medium in order to act upon the iron salts in solution.

EFFECT OF TARRED ROADS UPON VEGETATION —Various criticisms have been brought against the use of tar upon roads on the grounds of their effect upon vegetation and animal life, and a general outline of these is given in the current issue of *The Journal of Industrial and Engineering Chemistry* (1913, V, 428). In 1910 it was shown by MM. Truc and Fleig (*Comptes Rendus*, 1910, CLI, 593) that although bituminous vapours had but little influence upon the eyes the dust from old roads produced, through its mechanical action, inflammation and other troubles.

The following year M. Mirande (*Comptes Rendus*, 1911, CLII, 204) tested the effect of various coal tar products, such as creosote and the like, and came to the conclusion that these all had a destructive influence upon plant life, blackening the leaves and causing death. Mainly on the results of this investigation has grown up the belief that the tarring of roads is injurious to the neighbouring vegetation; but quite recently this has been refuted by other investigators. For example, it has been pointed out by French engineers that tar has been used in Bordeaux for many years without any injurious effects upon the trees. In another town, however, tar was apparently responsible for the destruction of the trees in a large square; but here its action was purely mechanical, for it had been spread so closely to the trunks that it prevented water from reaching the roots.

The conclusions of M. Mirande have also been called in question in Germany, and the results of experiments made by Dr. H. F. Fischer to determine the point are to be brought before the International Road Congress which will have met (June) in London prior to the appearance of this note.

STUDIES ON THE ELEMENT ZIRCONIUM.—Pure zirconium cannot be prepared by reduction with aluminium or magnesium, but a product containing about ninety-eight per cent. of the metal has been obtained by Herr Wedekind (*Annalen*, 1913, CCCXCV, 149) by the following method. Pure zirconium oxide was mixed with finely divided metallic calcium, and the mixture placed in an iron tube, from which the air was subsequently removed with an air-pump. The reäction between the calcium and zirconium oxide was started by heating the bottom of the tube, after which the exterior of the tube was cooled by means of a current of air, and finally by placing it in cold water.

After cooling, the contents of the tube were rapidly powdered, and treated first with water, then with acetic acid, and finally with dilute hydrochloric acid, care being taken to exclude air throughout the whole process. This treatment was continued until the whole of the calcium had been removed, the water being then expelled, and the powder dried first in a vacuum and finally at a high temperature in a porcelain tube from which the air had previously been extracted. The final product, which contained a small quantity of iron, had a specific gravity of 6·44 in the melted state. It melted at 1530°C., and at higher temperatures oxidised readily. The solidified metal when filed and polished had a fine surface, which did not tarnish on exposure.

A new compound, zirconium nitride (Zr_3N_2) was prepared by heating the metal in an atmosphere of nitrogen, and this could be decomposed by hydrogen at a high temperature with the formation of the theoretical amount of ammonia.

IMITATION PEARLS FROM GELATIN.—An ingenious adaptation of the process of diffusion of salts through a gelatin film is described by Dr. R. Liesegang (*Zeit. Chem. Ind. Kolloide*, 1913, XII, 181). It is based upon the fact that when certain saline solutions diffuse into gelatin the film becomes iridescent. The best results are obtained with dilute solutions of alkali phosphates and pure gelatin in the form of a ten per cent. solution. Beads intended to serve as the foundation for the imitation pearls are dipped into the warm gelatin solution and placed on a glass plate which has previously been coated with gelatin. Round each bead is then painted a ring of the ten per cent. phosphate solution, or in place of this a mixture of the phosphate and gelatin may be used for coating the glass plate.

Gradually there is a diffusion of the phosphate into the gelatin, and the desired iridescent effect is obtained. Special precautions are taken to prevent the beads drying too rapidly, and finally the gelatin may be hardened and rendered insoluble by exposure to the vapours of formaldehyde.

OCCURRENCE OF FORMALDEHYDE IN PLANTS.—A method of detecting formaldehyde in plant juices has been discovered by MM. Angelico and Catalano (*Gazz. Chim. Ital.*, 1913, XLIII, 38). It is based upon the fact that the plant *Atractylis gummifera* contains an active glucosidal principle (*atractiline*) which gives a specific reaction with formaldehyde, and will detect a mere trace of that compound. When the juice of the plant is brought into contact with atractiline and sulphuric acid, a violet coloration is immediately produced when formaldehyde is present.

By means of this test the aldehyde has been detected in the juices of eleven plants, including lupins, maize, and so on; and its formation is apparently connected with the chlorophyll function. This is indicated by the fact that when the same plants were kept for twenty-four hours in the dark no formaldehyde could be found. The juices and distillates from several species of fungi contained no trace of formaldehyde.

GEOGRAPHY.

By ALEX. STEVENS, M.A., B.Sc.

BIOGEOGRAPHY OF THE ATLANTIC ISLES.—The bathymetric charts of the Atlantic reveal a long submarine plateau running along the axis of the present ocean and bounded by symmetrical valleys on the east and west. The surface of the plateau is irregular, rising into peaks which project here and there in groups as the Atlantic Isles. Far out the Azores rise from the "oceanic axis," while the foundations of the Madeiras, the Canaries, and the Cape Verde Islands lie in the eastern trough. These archipelagos are of volcanic origin, and were the seat of a recent, Neolithic, it is thought, and considerable vulcanicity. The Madeiras are continuous with the Great Atlas. The materials of the islands are uniform—trachytes, basalts, and tuffs—and all the isles present the same appearance of towering mountains, trenched by deep valleys, cut off at the sea by vertical cliffs or running out into long promontories continued by tails of islets. The ocean platform also is covered with lavas which were certainly poured forth on dry land, but were covered by the sea before subaërial denudation could leave its mark on them.

A second group of the Atlantic Isles embraces those in the Gulf of Guinea and the distant Ascension and St. Helena. But these are remnants of the foundered Gondwanaland, and display a characteristic tropical African fauna. Louis Germain ("Annales de Géographie") has worked out faunal and floral connections for the northerly groups, particularly by means of insects and fossil and living molluscs; but he draws evidence from other phyla, worms, and arthropods generally. The islands are remarkably poor in vertebrates, notably in mammals; and this poverty has been used by Wallace, who considered the few vertebrates found in the archipelagos to be imported, as an argument against the possibility of a former continental connection. But Scharff has shown that the mammals are indigenous and came from Europe by a land passage, while Osborn, less convincingly, derives the rabbit from America. It is a matter for regret, nevertheless, that no traces of a possible extinct but once flourishing mammal fauna have been brought to light for purposes of comparison with American forms. On the whole the much larger part of the fauna is circummediterranean and the smaller American.

Where the Atlantic now rolls an old-time continent supported a large and varied fauna and flora. By the close of the Cretaceous the southern Gondwanaland portion was passing beneath the waves and a narrow gulf divided the northern part from America. Later, and perhaps within the memory of the human race, this too—possibly the Atlantis of Plato and the ancients, recalled only by uncertain oral tradition—passed. The waters encroached from the west, and the shore creatures of a fauna common to Atlantis and

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America were driven farther east till the last bond with the great eastern land-mass failed, and the ocean lapped the bounds of Mauretania.

GREAT EXPLORERS.—The geographical journals have recently been full of appreciations of Livingstone, and the fact has emerged that it is at least largely as a geographer that he will be remembered. To him is due a revolution in African exploration, and to his influence can be traced a beneficial effect on exploration generally. His mistakes, and particularly his curious tenacity in entertaining certain preconceptions in the face of contradictory facts gathered in his own work, have been made much of by certain critics. The wonder is that the accuracy of his observations and results has never been impaired under the influence of his prejudices. His maps show accuracy proportional rather to his energy in utilising stray opportunities of gaining instruction than to the extent of his training. It is related of him that he spent his time on his first voyage largely in learning from the captain of the ship how to determine positions by means of the sextant and in mastering the art. The result is that some of the stations he fixed were determined with sufficient accuracy even for many modern requirements. No man has made greater and more valuable changes on any map than he on the accepted map of Africa: to realise this one has but to glance at the series of maps earlier and later than his, published recently in the magazines. By virtue of his inborn capacity for leadership and the management of men, and his sympathetic grasp, he was able not only to bring away stores of information regarding the topographical and racial geography of Africa, but to leave behind the influence of a master mind and heart.

The Geographical Journal for June publishes an account, by Sir Clements Markham, of Vasco Nunez de Balboa, that singular man who reached Darien, "headed up in a cask," a fugitive on the ship of Enciso. At the helpless fort of Darien, in the midst of Indians, whose distrust and enmity had been aroused by Spanish cruelty and injustice, he was recognised as a born leader, and was obeyed by Pizarro himself, who was actually in charge. He regained the confidence of the natives, though with difficulty, and contrived to render the existence of the hitherto wretched fort possible. Informed by natives of the sea beyond the mountains which was always calm, he it was who first of white men saw the Pacific and stood "silent upon a peak in Darien." Superseded by an incompetent and unscrupulous gold-seeker, who had influence at Court, Nunez was nevertheless allowed to devote the remainder of his life to building ships on the western coast of the Isthmus for the exploration of the new ocean. Materials were brought from Cuba and dragged with infinite labour through the forest and over the mountains. But when he was ready with three hundred men to launch his four ships, he was "judicially" murdered by Pizarro and the rapacious Pedrarias. With the ships of Nunez, Pedrarias explored the coasts of Panama and Nicaragua. Nunez it was who rendered possible the invasion of Chile and Peru. Had he lived the conquest of the Incas had been earlier, and its story had been different.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE CONCEALED COALFIELD OF YORKSHIRE AND NOTTINGHAMSHIRE.—The proving of the concealed coalfield to the east of the Permian escarpment which runs from Nottingham along the boundary of the visible coalfield into Yorkshire and Durham began in 1854, when the Duke of Newcastle sank two pits at Shireoaks. Here the valuable Top Hard Coal was obtained at a depth of one thousand five hundred and thirty feet, and was found to be three feet ten inches in thickness. By far the greatest progress in the exploration of the concealed field, however, has been made since the beginning of the present century. The chief areas in which borings and shafts have been sunk are three in number: one, to the south of Nottingham, has been developed with a view to the London market; a large area has been proved in the central region between Nottingham and Gainsborough, near the navigable Trent; but the largest development has been made in the Doncaster district, where special transport facilities are available. The amount of information thus gained has become so large and valuable that it has become necessary to collect and summarise it in a publication of the Geological Survey, which has been written by Dr. Walcot Gibson.

The Nottingham and Yorkshire Coalfield is of the shape of a basin, of which only the western rim is visible at the surface, the remainder being concealed beneath successive sheets of newer formations to the east. The eastern edge of the concealed portion of the basin has not been reached in any of the borings yet made. A thickness of about four thousand feet of Coal Measures has been proved. Two borings each end respectively in the Upper and Lower Coal Measures; all the other borings and shafts end in the Middle Coal Measures.

The chief conditions which affect the accessibility of the coal in the concealed area are the thickness of the overlying strata; the configuration, structure, and folding of the Coal Measures; and the amount of denudation, if any, suffered by the latter before the deposition of the Permian. Where direct observation is possible it has been found that the Permian rests unconformably upon an even surface of the Carboniferous rocks, so smooth that a well-known graphic method has been applied to contour the surface of the hidden Coal Measures. The contour lines thus obtained are strikingly parallel, and show that the buried surface has a remarkably uniform slope directed a little to the north of east, and oblique to the north-west strike of the Coal Measures. Hence higher horizons in the Coal Measures tend to occur beneath the Permian cover than at the outcrop. At Kelham and Thorne, however, borings have shown that the Coal Measures rise, at least locally, on approaching the Trent; and if the general slope of the buried surface (ninety to one hundred feet per mile) is maintained here, the whole of the Coal Measures will be cut out by the newer formations. The area of the concealed coalfield already proved amounts to one thousand two hundred square miles.

ORIGIN OF TURQUOISE.—A theory of the origin of turquoise has been propounded by S. Paige ("Economic Geology," 1912, 382-92) to account for an occurrence of this gemstone in the Burro Mountains of New Mexico. The country rock is a Pre-Cambrian granitic complex, which has been intruded by quartz-monzonite with intense fracturing and mineralisation. The turquoise occurs in small veins within both the igneous rocks, and the veins are closely related to the surfaces of denudation. The author believes that the turquoise was formed by the oxidation of copper sulphides and pyrite in the zone of weathering, and the reäction of the resulting solutions with apatite. The latter would supply the necessary phosphorus to combine with the copper and aluminium of the solutions and thus form turquoise.

AN ENGLISH DESERT.—The Long Valley, Aldershot, is described by Alan G. Ogilvie in the June *Geographical Journal* as an area which exhibits many of the phenomena characteristic of deserts. The desert features, however, are not due to aridity, but to the ceaseless erosion effected by the hoofs and wheels of cavalry and artillery. This action has completely stripped the area of the original mat of vegetation, and has exposed the underlying sand and gravel to very rapid erosion. The Long Valley is now dissected by a system of stream-courses which reproduce all the essential features of desert wadys. These are only filled after heavy rain, and then contain rushing torrents which carry down large masses of sand and gravel. Ordinary rain showers have no effect, as the water percolates at once through the sand. Similarly the water from a continuous spring loses itself in the sand after running in a well-formed valley for about a hundred yards. The erosion due to wind is, however, more important than that of water. The wind is producing a steady lowering of the surface of the valley by blowing away the lighter particles. The finer dust is probably carried beyond the confines of the area, but the blown sand tends to form miniature dunes on its

margins, especially at the north-east corner facing the prevalent wind. The desert appearance of the Long Valley is shown in a series of striking photographs which illustrate the disastrous and desolating effects of the removal of vegetation from an area the climatic conditions of which do not differ from those of the surrounding districts.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

WINDS IN THE FREE AIR.—At one of the Friday evening discourses at the Royal Institution Mr. C. J. P. Cave dealt with the subject of the "Winds in the Free Air." He has for some years devoted a considerable amount of time and work in carrying on observations in the upper air, first by means of kites and subsequently by small rubber balloons, the movements of the latter being followed by a specially designed theodolite. The lower layers of the atmosphere up to one or two kilometres are the most important to aviators. To meteorologists the higher layers offer problems of greater interest. In considering the winds in the free air it is convenient to have some datum to which to refer them, and this is known as the gradient wind. Mr. Cave divides the wind structures into five types. In the first three the wind increases above the surface and equals the gradient velocity at a height of half a kilometre or so; above this, in the first class, the wind remains more or less equal to the gradient velocity up to a height of seven or eight kilometres; in the second class the wind in the upper air greatly exceeds the gradient wind; and in the third class it falls off again to a lesser value; but in all three classes the direction remains much the same as that of the gradient wind. There are often cases of reversals when the wind in the upper air is very different in direction from that near the surface, and when it bears no relation to the surface-pressure distribution. In cases of reversal it is found that the warm wind flows over the top of the one that comes from a colder region; there must somewhere be a line where the warm current is rising, where it must be cooled dynamically, and where its moisture may condense into cloud or rain. It is interesting to note that in most cases rain occurs somewhere in the region of the reversal, and in summer thunderstorms are frequent. The last type of wind structure considered was the outflow that seems to take place from the upper layers over a low-pressure system, causing west to north winds in the upper air on the east and south sides of the depression.

Following on inquiries made by Mr. W. H. Dines on the correlation between the surface pressure and various meteorological elements at a height of nine kilometres, Dr. W. N. Shaw has suggested that the changes of pressure to which our changes of weather are due have their origin, not near the surface of the earth, as hitherto supposed by many meteorologists, but just below the level of the stratosphere at a height of nine kilometres or so above the surface. Mr. Cave says that this view is in accordance with the observed facts of the wind distribution in the different layers of the atmosphere.

HOURLY OBSERVATIONS OF CLOUD FORMS.—Mr. Spencer C. Russell, who has always been a keen observer of clouds and thunderstorms, gave, at the May Meeting of the Royal Meteorological Society, the results of monthly and hourly cloud-form frequencies at Epsom for the eight years 1903–1910. He had observed during this period, almost single-handed, the amount of cloud and also the various forms of cloud visible at each hour, day and night. This was truly a most remarkable feat of endurance, but it is a valuable addition to this little-studied branch of meteorological science. He arranged the fifteen varieties of clouds into four groups, viz. (1) upper, (2) intermediate, (3) lower, and (4) clouds of diurnal ascending currents. The upper clouds, which include the Cirrus, Cirro-stratus, and Cirro-macula, show a marked prevalence during the summer with minima during the winter. Morning and evening maxima, with a midday decline, are common to all these varieties. The intermediate clouds, which include Cirro-cumulus, Alto-stratus, Alto-cumulus, and Cumulo-stratus, are also more prevalent in the summer than in the winter. The lower forms, which include Strato-cumulus, Nimbus, Fracto-nimbus, Fracto-cumulus, Stratos, and Fog, attain their maxima in the winter months, their minimum frequency being in the summer. The clouds of diurnal ascending currents, Cumulus and Cumulo-nimbus, are independent of any seasonal variation in hourly frequency, the maxima, at noon and 3 p.m. respectively, taking place at these hours in every month of the year.

The total number of individual records made by Mr. Russell approximate close upon 100,000. The Cumulus cloud yielded the greatest number of daily values (1,622), the Stratus coming next (1,155), but the Stratus had the greatest number of hourly records (13,497), the Cumulus being next (11,414).

METEOROLOGY AND MAGNETISM AT THE ROYAL OBSERVATORY, GREENWICH.—In his Report to the Board of Visitors of the Royal Observatory at the Annual Visitation on June 7th the Astronomer-Royal gave particulars respecting the meteorological and magnetic work carried on at Greenwich. The chief results for the twelve months ended April 30th, 1913, were: The highest temperature in the shade (recorded on the open stand) was 90°·0 on July 12th. On twelve days the highest temperature equalled or exceeded 80°·0, but none of these days occurred after July, maximum readings of 70° and upwards occurring only seven times in August, and not at all after. The lowest temperature during the same period was 24°·2 on February 23rd. There were twenty-seven days during the winter on which the temperature fell as low as 32°, or less than half the average. The mean temperature for the twelve months was 49°·8. The mean daily horizontal movement of the air was three hundred and ten miles, which is twenty-six miles above the average of the previous forty-five years. The greatest recorded daily movement was eight hundred and forty-five miles on March 19th, and the least fifty-six miles on October 11th. The total rainfall was 25·61 inches, or 1·49 inches greater than the average. The number of hours of bright sunshine was one thousand three hundred and thirteen out of a possible four thousand four hundred and fifty-seven hours, giving a mean proportion of 0·295, constant sunshine being represented by one. As compared with the previous twelvemonth the deficiency of more than five hundred hours is fully accounted for by the fact that in July, August, September, and April the duration of sunshine was only about half what it was in the corresponding months.

The magnetic elements for 1912 determined from observations in the Magnetic Pavilion are as follows:—

Mean declination	... ...	15° 24′·3 West
Mean horizontal force	...	0·18528 (in C.G.S. units)
Mean dip	... ...	66° 51′ 46″

The Astronomer-Royal stated that in the new magnetic observatory shortly to be erected provision is made for the continuation of the long series of Greenwich observations of the variations of the magnetic elements. This series is unique as regards the length of time during which observations have been made on the same site. The care which has been taken to guard the observatory from all artificial electro-magnetic disturbances which could affect the accuracy of the observations has preserved the suitability of the site for such work. The present wooden structure, however, is old, and needs extensive repairs or renewal. The latter course was considered preferable, and designs have been prepared for a new building in the Magnetic Pavilion enclosure in the Park, where the absolute observations are made. The main feature of the building is the provision by insulation and heating for the reduction of the daily range of temperature. Also, to avoid damp, it will be above ground. The building will therefore be adapted to house a set of modern instruments. Although the change of site is small, the new and the old instruments will be run concurrently for a period sufficient to give a good comparison between the two.

THE ATMOSPHERIC TURBIDITY OF 1912.—The great deficiency of bright sunshine referred to above was not confined to Greenwich only, and it was no doubt connected with

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the unusual haziness that overspread most of the northern hemisphere during June, 1912. This appears to have been the result of the eruption of Katmai Volcano in Alaska. This volcano became suddenly active on June 6th, and violent explosions were frequent during the three days that followed. The eruptions continued with greatly diminished energy until the end of October, and perhaps until the end of the year. Professor H. H. Kimball, of Mount Weather Observatory, U.S.A., who has been investigating the subject, has found that in connection with the atmospheric haziness noted by many observers, but more especially by those engaged in astronomical photography, there was a decrease in atmospheric transparency of from ten to twenty per cent. The solar radiation intensities measured at the Mount Weather Observatory, after June 9th, 1912, were below the average, and the percentage of polarisation of skylight on cloudless days was abnormally low. These low values seem to be due in some measure to volcanic dust in the upper atmosphere.

INTERNATIONAL METEOROLOGICAL COMMITTEE.—A meeting of this Committee, which consists of representatives of the principal meteorological services in various parts of the world, was held in Rome from April 7th to 12th. Dr. W. N. Shaw, F.R.S., the Director of the Meteorological Office, London, is the President, and Dr. G. Hellmann, the Director of the Royal Prussian Meteorological Institute, Berlin, is the Secretary of the Committee. Among the subjects which came up for consideration were Weather Telegraphy, Weather and Agriculture, Investigation of the Upper Air, Meteorological Units, Sunshine Recorders, and Storm-warning Signals.

MICROSCOPY.

By F.R.M.S.

AN APLANATIC AND ACHROMATIC CONDENSER.—An attempt to modify the ordinary refracting substage condenser used for observation with transmitted light, so as to render it available for use as a dark-ground illuminator, has led to the construction of an Aplanatic and Achromatic Condenser. The ordinary condenser of N.A. 1.40, which consists of three lenses, though corrected for neither spherical nor chromatical aberration, is nevertheless available as a means of producing dark-ground illumination, but its deficient chromatic correction gives rise to colour effects which interfere with the quality of the resulting image: this defect can be remedied by achromatising the condenser. This quality alone would not, however, have placed the condenser on a level with the reflecting condensers, seeing that these, in addition to being naturally achromatic, are also excellently corrected with respect to spherical aberration. To compete with these the refracting condenser must needs be aplanatic as well as achromatic.

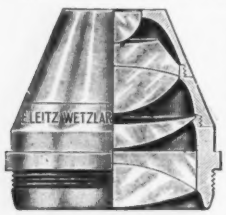

FIGURE 271.
The Condenser.

To meet this requirement the condenser constructed in 1907–8 by Leitz has recently been further improved in the matter of spherical correction. In the majority of cases objects which are observed with dark-ground illumination are examined in an aqueous medium, having a refractive index barely exceeding that of water, *i.e.*, 1·33. Every ray whose aperture is numerically greater than the refractive index of the medium containing the objects is totally reflected at the surface of the medium, as can be easily shown by a simple calculation, and the rays so reflected do not contribute to the illumination of the object. In order that the whole of the light which a condenser is capable of receiving when opened to its full aperture may be brought to bear upon the preparation, the condenser must have an aperture of 1.33, that being the refractive index of water.

The new condenser has lenses of the same diameter as the older type with N.A. 1·40; however, when used with aqueous media, it produces a more brilliant illumination than the latter. In the most recent form of the reflecting condenser, the so-called Concentric Reflecting Condenser, we have also a practical application of the above reasoning.*

As will be seen from Figure 271, the condenser consists of two doublets on either side of a meniscus and a hemispherical front lens. In its general construction it resembles an oil-immersion lens and, as a matter of fact, it is computed on precisely similar lines.

Although the condenser has been corrected as an immersion condenser its qualities will be impaired only very little when being used dry if the layer of air between condenser and slide is kept as thin as possible. In this case, however, the aperture is reduced to N.A. 1·0, since all rays of higher aperture are totally reflected.

In addition to being both achromatic and aplanatic, this condenser also satisfies the sine condition.

The focal lengths are 14·5 in immersion contact and 9·6 millimetres dry, and the effective aperture of the back lens is 26 millimetres. The light-transmitting power of the condenser is at least not inferior to that of a condenser constructed of single lenses of similar diameter; the loss of light due to absorption in its passage through the six lenses of the new condenser is fully compensated for by the manner in which the rays appertaining to the different zones are brought to a focus. This quality, coupled with the other conditions which are satisfied by the formula of the condenser, furnishes an efficient means of projecting a sharp, even, and colourless image of the source of light in the plane of the object; in the methods of photomicrography this is of great importance.

Continuous use and practical experience must show whether the refinements in the correction of the aplanatic condenser and its large aperture will secure tangible results in ordinary microscopic observations with transmitted light, both direct and oblique, especially in the case of objects which are difficult to resolve. Under the conditions of dark-ground illumination the excellent correction of the aplanatic condenser shows itself in an unmistakable manner, and every effort has been made to provide the condenser with qualities that will satisfy all the most advanced requirements of modern observation by this method of illumination. The extent to which the spherical aberration has been successfully corrected is clearly shown by the photograph reproduced in Figure 276 of the path, within fluorescent uranium glass, of the intersecting pencils of rays, which method was first used by the firm of Ernst Leitz in 1910. It will be seen that the pencils intersect within a very small area, and this furnishes an estimate of the resulting brightness of the illuminated field. By reason of the excellent correction of spherical and chromatic defects, and since also the sine condition is satisfied, the objects can be illuminated on a dark ground in such a manner that the image is seen free from colour, without distortion, and without disturbing flares.

The requisite conditions for observation against a dark background are established by the use of a central stop (see Figure 273) which rests on the carrier of the iris-diaphragm. The illumination is derived from the peripheral zones only of the pencil of light: these pencils are indicated by dotted lines in the annexed diagram, which shows the path of the rays through the aplanatic condenser and an oil-immersion lens. The image as seen in the microscope (see Figure 277), derives its existence exclusively from refracted and diffracted light emitted by the object.

The following points respecting the central stop may be noted. The disc of the smallest central stop, which is attached to the outer ring by three radial arms, has a diameter of 16 millimetres, and bears the number 0·85, whilst the ring is inscribed 1·33. All parallel rays entering the condenser within the annular zone, corresponding to an

* Cf. F. Jentzsch, *Ueber Dunkelfeldbeleuchtung, Phys. Zeitschr.*, XI, 1910, pages 993–1000; *Verhandl. der D. Physik. Gesellschaft*, XII, 1910, pages 975–91.

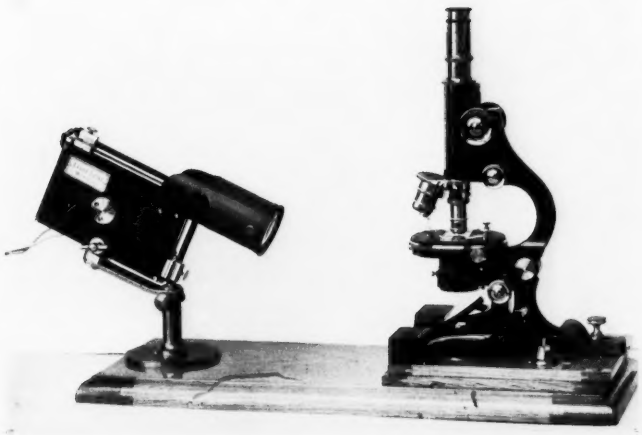

FIGURE 272.
A Liliput arc-lamp placed in position for use with the condenser.

FIGURE 273.
Central stop.

FIGURE 275.
An objective with the nickel-plated part unscrewed.

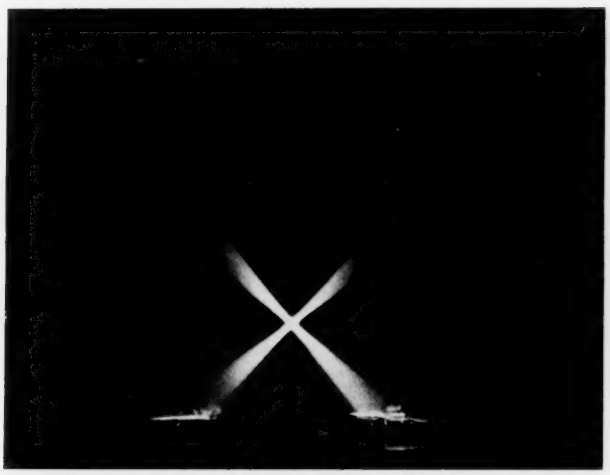

FIGURE 276.
The intersecting pencils of light within fluorescent uranium glass.

FIGURE 274.
Two of the loose discs.

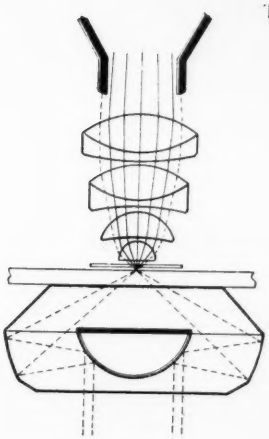

FIGURE 277.
Diagram of the condenser and an immersion objective. The dotted lines indicate the pencils of light.

FIGURE 278.
Snapshot taken upon an orthochromatic plate with the aid of a screen. Reproduced from a platinum print.
(See page 274.)

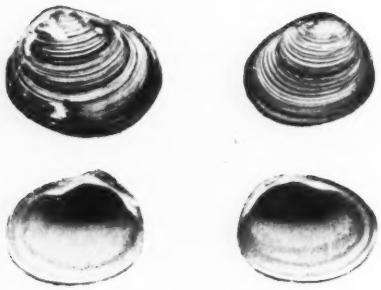

FIGURE 279. *P. amnicum* Müller.

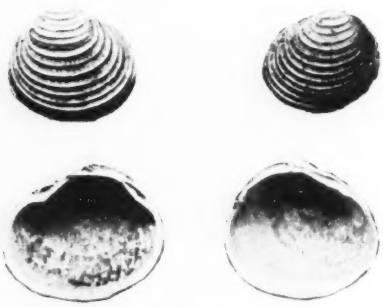

FIGURE 280. *P. astartoides* Sandb.

FIGURE 281. *P. casertanum* Poli.

FIGURE 282. *P. nitidum* Jenyns.

FIGURE 283. *P. personatum* Malm.

FIGURE 284. *P. pusillum* (Gmelin) Jenyns.

FIGURE 285. *P. milium* Held.

FIGURE 286. *P. pulchellum* Jenyns.

FIGURE 287. *P. subtruncatum* Malm.

FIGURE 288. *P. henslowanum* Shepp.

FIGURE 289. *P. supinum* A. Schmidt.

FIGURE 290. *P. steenbuchii* Möller.

FIGURE 291. *P. lilljeborgii* Clessin.

FIGURE 292. *P. hibernicum* Westld.

FIGURE 293. *P. obtusale* (Lam.?) Jenyns.

FIGURE 294. *P. vincentianum* B. B. Woodw.

The fifteen British Species of *Pisidia* recognised by Mr. B. B. Woodward in the Catalogue recently published by the British Museum (Natural History), and a New Species described by himself.

apertural range extending from 0·85 to 1·33, are allowed to participate in the illumination. The objectives employed for observation should in these cases have apertures which are less than N.A. 0·85, such as the Leitz objectives, Nos. 2 to 5, having respectively focal lengths ranging from 24 to 5·4 millimetres, as well as the apochromatic lenses of 8 millimetres and 16 millimetres focus. To use high-power objectives, having apertures exceeding N.A. 0·85 in conjunction with the central stop, it becomes necessary to reduce their aperture to less than N.A. 0·85 by a stop situated behind the back lens. To modify the range of the peripheral zone three loose discs, two of which are shewn in Figure 274, bearing the following numbers, 1·0, 1·1, 1·2, are provided with the stop. Each disc has a central hole fitting a small pin at the centre of the immovable disc inscribed 0·85. When one of these discs is pressed down upon this pin the cone of illumination becomes reduced, so that an aperture of 1·0, 1·1, and 1·2 is respectively employed; these discs are used when observing with objectives having an aperture of 1·0. Oil-immersion lenses have their aperture reduced to 1·0 for observation with dark-ground illumination by unscrewing from the body of the objective the nickel-plated part of the mount (see Figure 275), which contains the optical system, and screwing it to an adapter fitted with a conical stop, which is so arranged that it cuts off all rays which would pass if the numerical aperture of the lens were greater than 1·0. In the case of dry lenses it is generally desirable, to obtain an intensely dark background, to employ one of the larger stops; in the majority of cases the one marked 1·0 is sufficient for this purpose. For observation with dark-ground illumination it is always an advantage to use objectives of high degree of chromatic correction—for instance, fluorite lenses or apochromatic lenses—since under the conditions of dark-ground illumination the residual colour defects of the lenses, known as the secondary spectrum, are of much greater importance than is the case in ordinary observation with transmitted light. The best source of light to use with dark-ground illumination is the Liliput Arc Lamp, which has been specially devised for this purpose. This lamp burns carbons set at right angles to one another and consumes five amperes: it is so arranged that it may be connected with the ordinary domestic electric supply by means of a plug contact. The light emitted by this lamp is rendered parallel by a condensing lens attached to the lamp casing, and is reflected by the plane mirror of the microscope into the condenser, the latter being adapted for parallel light. The lamp, being hinged, moves in a vertical plane, and should be so set that the plane mirror may be completely filled with light. The lamp should be placed at such a distance from the microscope that the observer may be able to manipulate it without inconvenience, as shown in Figure 272. When using dry lenses a ground-glass screen may be interposed between the lamp and the mirror; the contrast between a dark-ground and a brightly illuminated object is thereby intensified. When using low-power lenses having apertures not exceeding 0·40 the condenser may be used dry; with lenses of higher power the condenser should be used in immersion contact with the object slide; it will generally be sufficient to employ water as the optical medium. The adjustment of the dark field is not always an easy matter with high-power lenses; it may, however, be greatly simplified by the following procedure:—

The object should be viewed first with an objective of medium power, say No. 3 Leitz Objective, in conjunction with a high-power eyepiece. Incidentally it may here be noted that high-power oculars are particularly useful in observations under dark-ground illumination. Focus the lens in the plane of the object, the object slide being at this stage connected to the condenser by a drop of oil. By the requisite movement of the substage mirror direct the light upon the object. Under good conditions of adjustment the circle of bright light should appear in the middle of the field of view, and it should be sharp and free from colour. The condenser should be raised or lowered until the spot of light becomes as sharp as it is possible to make it. Having prepared the adjustment in this way a very small correction in the position of the mirror and condenser will be needed to secure a very perfect dark ground. These manipulations are sufficient to obtain the necessary adjustments, and there is no need to have recourse to centring screws.

The transition from dark background illumination to ordinary observation with transmitted light, and *vice versa*, can only be made in the case of a refracting and not in that of the usual reflecting condenser; for this purpose a useful special arrangement has been devised.

The ordinary conical stop with which lenses of high aperture are fitted to render them available for observation with dark-ground illumination is replaced by a small iris-diaphragm fitted to the body of the lens mount. When the lens is used for observation with an ordinary bright field this diaphragm should be opened to its full extent, and it should be partly closed for observation with dark-ground illumination. In order to pass rapidly from one mode of illumination to the other the iris-diaphragm carrier below the condenser is provided with a central stop attached to a slide by means of which it may readily be pushed in or withdrawn.

It may be useful to point out the distinctive features of a refracting condenser. In the case of a reflecting condenser the course of the rays is solely determined by a series of reflections. In refracting condensers the illuminating pencils are brought to a focus by refractions at the surfaces of the constituent lenses. In addition to these refractions, however, the rays undergo certain reflections which may impair the distinctness of the image as seen in the dark-ground field. It seems almost hopeless to construct an aplanatic and achromatic condenser which needs correction by the use of so many kinds of glass and refracting surfaces, and in such a way that every surface must be excluded from which reflected rays after successive refraction and reflection shall yet leave the condenser at such an angle as to enter the plane of the object. These indirect rays which cannot altogether be avoided, however faint they may be, impair the blackness of the background which is never the same as that obtainable with a reflecting condenser, and under these circumstances the clearness of the image may suffer.

The condenser described above, on the other hand, has the advantage of being of the nature of a universal illuminator, and in this respect it surpasses all existing reflecting condensers. Primarily, a highly refined illuminator adapted for the various purposes of visual microscopy with transmitted light and photo-micrography, its performance as a dark-ground illuminator entitles it to a prominent position among the condensers devised for this purpose. Far from being restricted in its use to high-power objectives, it illuminates a sufficiently large field to render it suitable for use with low-power objectives whose focal lengths may be as much as twenty millimetres. The only optical device of the nature of a reflecting condenser which can be regarded as a dark-ground illuminator is our old friend the concave mirror: this can be converted into a makeshift for a dark-ground condenser by covering up the central portion of the mirror. Owing to its small apertural angle the mirror can be used in this way only in conjunction with lenses of a very low power.

C. METZ, Wetzlar.

THE BRITISH SPECIES OF *PISIDIUM*.—Those who study British land and freshwater shells—and they are many—owe a deep debt of gratitude to Mr. B. B. Woodward for determining what species of *Pisidium* are British and for clearing up all the doubts and difficulties which have long surrounded these small freshwater bivalves. After examining many thousands of specimens under the microscope, and devoting his leisure hours during nine winters to the subject, he has come to the conclusion there are fifteen British forms worthy of specific rank, of which all but one (*P. astartoides*) are still living in this country. Photographs of these by the kindness of Mr. Woodward we are permitted to reproduce on page 272 (see Figures 279 to 293).

The determination of the species is based to a large extent upon the hinge characters of the shell and the form and position of the various hinge "teeth."

P. casertanum (see Figure 281) is a species which haslong been known on the Continent under this name or that of

P. fontinale. *P. nitidum* Jenyns (see Figure 282) still stands, and Mr. Woodward points out that it has frequently been mistaken for small specimens of the last species, *P. personatum* or *P. pusillum*. *P. personatum* (see Figure 283) was recorded as British by Mr. Woodward in 1908. This, again, has often been confounded with other species, and its detection has helped very greatly to clear matters up. *P. pusillum* (see Figure 284), *P. millium* (see Figure 285), and *P. pulchellum* (see Figure 286) still stand. *P. subtruncatum* was identified as British by Dr. Johansen, who pointed it out to Mr. Woodward in 1901 (see Figure 287). This was looked upon as a variety of *pulchellum* by Jenyns, and is the var. *pallida* of Jefferys' *P. fontinale*. *P. henslowanum* (see Figure 288) is recognised by Mr. Woodward. *P. supinum* was found by Dr. Johansen near Kew Gardens in 1901. Mr. Woodward describes *P. parvulum*, which has not yet been met with in Britain, and is the smallest of the Western European species. P. *steenbuchii*, *P. liljeborgii*, and *P. hibernicum* (see Figures 290 to 292) are species that were not recognised till recently. *P. obtusale* (see Figure 293) is an old friend. We figure also *P. vincentianum*, a fossil form from the Pleistocene of Belgium, which is a new species described for the first time by Mr. Woodward, but which has not yet been discovered in this country (see Figure 294).

Mr. Woodward's researches have been published by the British Museum (Natural History) as a catalogue consisting of one hundred and forty-four pages and thirty plates, the greater part of which latter consists of collotype reproductions of photographs of many hundreds of shells. In the case of every species the hinges and hinge-teeth are described in great detail. Symbol maps (in accordance with those agreed upon by the British Association Committee for "The Formation of a Definite System on which Collectors should record their Captures") are also given, which show recent as well as fossil records. A detailed list of localities for each species is also included, and the synonomy, which in some cases runs into two or more octavo pages, gives some little idea of the work which Mr. Woodward has accomplished. Every collector of land and freshwater shells will now have to check his specimens of *Pisidia* and redetermine them with the help of Mr. Woodward's book which can be obtained at the British Museum (Natural History), Longmans, Green & Co., B. Quaritch, or Dulau & Co. Price 10/6 net.

W. M. W.

ORNITHOLOGY.

By WILFRED MARK WEBB, F.L.S., F.R.M.S.

THE COMMITTEE FOR THE ECONOMIC PRESERVATION OF BIRDS.—We learn from the July number of *The Selborne Magazine* that at the meeting of the Council of the Selborne Society, held on November 26th, 1912, Mr. Holte Macpherson and the Secretary were empowered to confer with Dr. Chalmers Mitchell and others, including members of the trade, as to the best steps to be taken to preserve birds which are being killed off for their plumage. Subsequently Mr. Macpherson, Mr. Poole, and the Secretary were given formal authority to represent the Society on the Committee for the Economic Preservation of Birds, to which also the London Chamber of Commerce has appointed representatives. Many leading zoölogists have joined the Committee which is now beginning active work.

In the past, bird-lovers have sought to secure legislation without stopping to consider whether the objects they seek will be obtained. On the other hand the trade has occupied itself with opposing all legal measures, and nothing has been done. It is hoped, however—now that naturalists and merchants are combining to consider the question—that some steps will be taken to preserve birds whose plumage is used in commerce. Anyone who has evidence to offer with regard to the killing of birds for trade or natural history purposes is invited to communicate with the Honorary Secretaries of the new Committee, care of the Selborne Society, 42, Bloomsbury Square, W.C.

PHOTOGRAPHY.

By EDGAR SENIOR.

PLATINUM PRINTING.—Of the many processes of photographic printing there are few which equal in simplicity, together with the beauty of the results obtainable, that known as platinum printing (see Figure 278). For while it is capable of rendering shadow detail in a most perfect manner, it is at the same time able to reproduce all the delicate gradations in the lights. Then there is the additional advantage of permanency, for which both platinum and carbon stand pre-eminent, and although the former does not enjoy the advantages attending the latter, of giving an almost unlimited choice of colours, both warm or cold blacks and sepia are readily obtainable. The papers manufactured by the Platinotype Company, Gevaert Limited, and others are of several grades or kinds, which refer to the surface, texture, and thickness. As the paper has a great affinity for moisture, special precautions have to be taken to keep it in a perfectly dry atmosphere, and neglect of this is a great cause of so many failures in practice. Therefore, in order to keep the paper in good condition, it is sent out by the makers in sealed-up tins containing a small quantity of a desiccating agent (calcium chloride) which absorbs the moisture contained in the air enclosed in the tin. In this manner the paper will keep perfectly dry for a lengthened period, the writer having found it to be in perfect condition after the expiration of two years. As soon, however, as the tin is opened the paper must be removed to a storage tube which is provided at one end with a receptacle for containing the calcium chloride, and this salt must be frequently dried and replaced in the tube; in fact, it cannot be too strongly urged upon those who use platinum paper to keep their tins in a dry place, as well as keeping the calcium chloride dry. If these points be attended to there will not be any difficulty in preserving the paper in good condition. Neglect of these simple precautions is seen in the flat, muddy, sunken-in appearance of the image. One of the first considerations is the kind of negative that will give the best result by this process; it may, however, be taken for granted that any negative which possesses good gradations from high lights to shadows will yield a good print, but that poor, flat, or thin ones will not be suitable as a rule. Before commencing printing, it is necessary to dry the printing frames, and especially the backs, thoroughly before a fire. The negative is then placed in the frame and the coated surface of the paper in contact with it, this operation being conducted in as subdued a light as possible, as the paper is much more sensitive than the P.O.P., and the effect of short exposure to light is not apparent until after the print is developed. In order to protect the paper from moisture during the time of printing it is usual to place a piece of vulcanised rubber upon it before placing the back of the frame in position; several sheets of waterproof paper can, however, be made to answer instead. The paper before exposure to light is of a lemon-yellow colour; as the printing proceeds it changes to a greenish-grey, the shadows finally becoming a blue-grey and with some negatives a slight orange-brown colour. It is not advisable, however, to continue the printing until the detail in the lights is plainly visible. The time of exposure necessarily varies with the kind of negative, but it is about one third of that required for a silver print. It is evident that the progress of printing can be inspected from time to time; but as over-printing is not made apparent until development has taken place, some amount of experience is required to know when printing should be stopped. This knowledge, however, will soon be acquired after a few trials. But it does constitute a vital point in the process. If thought desirable, one of the many forms of actinometers may be employed in printing, although they are of little use unless a number of prints are required from one negative; in which case they are a help in ensuring that the printing shall be carried to the same depth in each case. The printing having been carried far enough, the next operation is that of development. This may be carried out at once, or the exposed paper may be returned to the calcium tube until a

more convenient time. The reason of its being necessary to develop the print is owing to the light having acted upon the iron salt only, and before the product formed is able to reduce the platinum salt in contact with it it becomes necessary to float the exposed paper upon a solution of either potassium oxalate or a mixture of this with sodium phosphate, known as developing salts. Using the former, a stock solution is made as follows:—

Oxalate of Potash	16 oz.
Water	54 oz.

For use one part of this is diluted with two parts of water. If this bath is made slightly alkaline with carbonate of soda or potash it gives slightly warmer tones, and if made slightly acid by means of oxalic acid, a colder or bluish colour results. In either case the alkalinity or acidity should only be such as to just alter the colour of the test paper used. If developing salts are used, then a stock solution of the following strength is prepared:—

Developing Salts	½ lb.
Water	50 ozs.

And for use one part is taken to which is added one part of water. It is claimed for this developer that it gives better half-tones, as well as a colder tone generally. Whichever developer is employed, the print is floated face downwards upon it, the print being then turned over to watch the progress of development, which should be complete in about thirty seconds. The temperature of the solution should be from 60° to 100° F. If the solution be below 60° the deposit is liable to become granular, while if too hot there is a tendency to a brown and muddy colour, although under-exposed prints may frequently be saved by use of a warmer solution for their development. As soon as the desired result is obtained the print is placed into a dish containing a dilute solution of hydrochloric acid, the strength being —

Hydrochloric Acid (pure) ...	1 oz.
Water	100 oz.

The prints are allowed to remain in this bath for ten minutes, after which they are transferred to a second bath of the same nature, and finally to a third, remaining for ten minutes in each. After this they are washed for about half an hour in several changes of water, a little carbonate of soda being put into the last washing water to ensure the removal of all trace of the acid. If the prints on removal from the water are placed between blotting boards and allowed to dry slowly, they will be found to remain perfectly flat and ready for mounting by any method that may be thought most desirable.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

IS SODIUM RADIOACTIVE? — It is a somewhat striking fact that potassium and rubidium are radioactive; that is, they emit spontaneously radiations consisting of negatively charged particles, or β-rays. The electrical effect produced by these rays from potassium is only about a thousandth of the effect produced by the radiations from an equal weight of uranium. Experiments seem to show that this small effect is due to β-particles spontaneously emitted from the potassium or rubidium atom, and that these atoms can therefore be described as being radioactive. N. Campbell, who made this interesting discovery, has continued his researches on the feeble activity of substances and has investigated what are termed the δ-rays—rays which are too feeble to ionise a gas and render it capable of conducting electricity. The energy in ergs necessary to ionise an atom is $4{\cdot}2 \times 10^{-11}$; hence if the velocity of the electrically charged particle which collides with the atom is less than $\sqrt{\frac{4{\cdot}2 \times 10^{-11}}{\frac{1}{2}m}}$, *i.e.*, $3{\cdot}6 \times 10^{8}$ centimetres per second, where m (the mass of the electron) is equal to $6{\cdot}5 \times 10^{-28}$ (the mass of the electron bears the same ratio to a grain of wheat as the latter does to the whole mass of the earth), the electron will not be able to ionise the atom, and can only be detected by the charge it carries and can give up to a conducting body. The velocity of such δ-rays have been measured and are of the order 3×10^{8} centimetres per second, or smaller than the velocity necessary to ionise an atom of a gas through which they pass.

Now sodium is in the group of elements which are similar to potassium and rubidium, but no radiations are detectable from it, neither does lithium give any measurable radiation. It is curious that there should be these two elements, potassium and rubidium—more or less light atoms as compared with the heavy, unstable, radioactive elements such as uranium, radium, and thorium—which show radioactivity and stand alone in this respect. Such a fact raises the question whether most elements do not emit characteristic radiations spontaneously to a slight extent, but that the radiations are moving too slowly, and the radioactive changes are proceeding too slowly, both for the rays to be detected by their ionisation or for the rays to be detected by the sum of their individual charges.

Some evidence for the radioactivity of sodium has been brought forward by F. C. Brown in *Le Radium* for October, 1912. Although no measurable radiation is emitted by it, yet from certain geological considerations there seems to be some reason for the view. Joly has calculated the age of the earth from the salinity of the ocean and the amount of salt carried down to it by the rivers. The value is seventy million years. However, from the amount of helium or of uranium in rocks a measure of the age of the earth is also obtained, and this makes the figure four hundred and twenty million years. Consequently, if the latter value is correct, there is too little salt in the ocean or too much carried down at the present time by rivers; if sodium was a member of a radioactive series of elements there would be too little sodium in the ocean and too much in the rivers, and in support of the actual fact the proportion of sodium to chlorine in the rivers would be such that the sodium would be in excess, whereas in the sea the reverse would be the case.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

BREEDING LEECHES.—M. Moshin Khan gives an interesting account of the breeding of leeches in the United Provinces of India. It is the occupation of a class of people called "Chohra." In April or May selected leeches are put in earthen pots with "hair-cleaning clay" and a little water, and the pots are put out of reach of all disturbances; for the leeches are very sensitive when laying their cocoons. When these are formed and have hardened, they are picked up and put into closed cups of clay, which are changed every alternate day for a fortnight. Then the breeders help the young leeches out by breaking the shells. Each cocoon contains five or six young ones. The young leeches are reared in fresh water, and the breeder gives them meals from his own body. Those that are sold for medical purposes are said to lose their power of breeding; so special "seed leeches" are put aside. A leech stops sucking at once if there is any pus mixed with the blood of the patient. The Chohra cleans a gorged leech by puncturing it dorsally near the head and pressing the blood out from the tail forwards.

AN INSECT PROTECTED BY ITS MEALS. — Dr. A. Ch. Hollande, of Nancy, reports a very interesting case of protective coloration. The flower-buds of one of the mountain mulleins, *Verbascum nigrum*, are pierced in autumn by the larva of a Curculionid beetle called *Cionus olens*, which eats the violet hairs of the stamens. The violet vegetable pigment (anthocyan) eaten by the grub passes down the food-canal and, as usual, into the blood (in some uncoloured form). It is carried to the fatty bodies and accumulates there in numberless granulations, again of

a violet colour. The colour, shining through the brownish integument, makes the grub most effectively harmonious with the colour of the stamens amid which it works.

DEATH-FEIGNING IN INSECTS.—This very interesting reäction has been carefully studied by Professors H. H. P. Severin and H. C. Severin with especial reference to *Belostoma* and *Nepa*, two water-bugs. The death-feigning positions are characteristic and definite, unlike those of the dead insects. The average duration of the "feint" in *Belostoma* was eight hours, and it is proved that the length is affected considerably by the external conditions of drought and illumination. The death-feint continues even when the head of *Belostoma* is cut off, and decapitated specimens will often swim freely after arousing from the feint. Both the water-bugs studied are very sensitive to contact stimuli, and in both species there is a marked propensity to cling together and form clusters. The investigators do not think that there is any conscious effort to deceive enemies through the death-feigning. The act is non-intelligent and wholly instinctive.

FECUNDITY OF THE POMACE-FLY.—In some Lepidoptera the reproductivity of the adult female depends wholly on the nutritive conditions of the larva. In other cases like the blow-fly, almost everything depends on the nutrition, of the adult. In the pomace-fly, *Drosophila ampelophila*, the nutritive conditions of any period have their effect on the number of eggs produced and laid by the female fly. This has been shown very clearly by Emile Guyénot. Immature flies fed on potato become mature in seven to thirteen days and lay an egg per diem; but those fed on potato and yeast become mature in four to five days at the most and lay ten to fifteen eggs per diem to begin with, and twenty to twenty-five later on. Mature females fed on yeast while immature, but afterwards placed on potato diet, begin to lay a day after their emergence, and they exhaust themselves towards the end of the third day, thereafter producing only one or two in a day. But their sisters, kept on potato and yeast, continue producing a regular twenty to twenty-seven eggs every day. Thus the influence of nutrition on fecundity is made very clear.

CAVE SPIDERS.—Louis Fage has made a study of a family of spiders, Leptonetidae, whose members are almost all restricted to caves and grottos. There are some interesting features. Thus it is not usual to find more than one species in one cave, as if there were some intolerance of strangers in the darkness. The webs spread among the stalactites and roughnesses are very large and delicate. The spinners move very slowly. If there is the least disturbance they either quicken their pace or play possum with their limbs laid along their body. In most spiders the males are found only at certain seasons, but in the uniformity of the caves they are found all the year round. The reproduction is not punctuated. In the few cases where the eggs are known, the interesting feature is that each cocoon contains very few, but these are large. In some cases there are only two eggs; in *Telema tenella* there is only one in each cocoon. It is two-fifths of a millimetre in diameter and the whole spider is only about a millimetre. The adaptation here is that the young spider is vigorous when hatched. It has had the advantage of a big legacy of yolk.

INFLATION IN FISHES.—For a very long time it has been known that many globe-fishes and their relatives have the power of inflating themselves and floating on the surface. Nils Rosen has been studying the mechanism of the inflation. It is the air-sac that is filled—by swallowing movements. The air is kept in by means of circular muscles in the wall of the gullet and by a valve, or by means of a special closing muscle. As a result, the body is like a football, and if there are spines they stand out. The Diodons turn upside down and are driven about on the surface of the sea by waves and currents. It is a protective adaptation. The air-sac is emptied by the relaxation of the muscles mentioned above and—in Diodons and Tetrodons, at least—by the action of the ventral body muscles, which are adapted to this purpose.

GIZZARD OF BEETLES AND ORTHOPTERA.—It has been too hastily assumed that the gizzard of insects, like the water-beetle and the cricket, functions as a mill for grinding up hard parts. Willy Ramme finds that it is mainly an organ which allows some of the digestive juice of the mid-gut to pass through into the crop, and which works up a sort of mash of food and digestive juice. In all the insects studied the digestive juice of the mid-gut was found in the gizzard (or proventriculus) and in the crop. In *Dytiscus* the indigestible parts, *e.g.*, chitinous fragments, are kept back by the proventriculus and passed out again. In Orthoptera the indigestible debris passes on through the intestine.

FUNGUS GROWING ON HAIR OF ECHIDNA.—Karl Toldt reports the occurrence of an entirely new hair-fungus which he found spreading its hyphae over and in the cortical substance of the bristle-like hairs of *Zaglossus* (*Proechidna*) *bruijni* from New Guinea. He suggests that an examination of the hairs of the rarer mammals would reveal the existence of some new and interesting Fungi.

HOW MUCH DOES A STARFISH SEE?—At the end of each arm in the common starfish there is a little red eye. It is sheltered at the base of the terminal tube-foot, which has become altogether sensory. The eye or eye-cushion shows numerous little cups, each closed by a lens, lined by red rod-like sensory cells, clothed externally by supporting cells, and containing a transparent watery substance. Hellmuth Plessner has recently made a number of experiments at Heligoland in order to discover how much a starfish sees with these "eyes," or eye-spots. The answer is: Not very much. It does not form an image nor does it perceive a moving object. But it has considerable sensitiveness in distinguishing different degrees of light and shade. Even the skin of the starfish is responsive to differences of illumination in the immediate vicinity, but by means of its "eyes" the starfish becomes aware of distant illumination that differs, either positively or negatively, from that of the immediately surrounding area.

FERTILISATION AND CONJUGATION.—When an egg is fertilised there is an intimate and orderly union of the nuclear elements of the egg-cell with those of the sperm-cell. The number of chromosomes in each has been reduced during the ripening process to half the number which is normal for the species in question. Thus in fertilisation there is a restoration of the normal number. It must also be admitted that the spermatozoön brings with it an extremely minute quantity of cytoplasm, which probably has some significance. It is also well known that the spermatozoön introduces into the egg-cell a centrosome, which divides into two and plays an important rôle in the subsequent segmentation. The fertilising spermatozoön keeps the egg from dying, as in all ordinary circumstances it would otherwise do, and gives it some initiative to development. In certain cases (of artificial parthenogenesis) this part of the sperm's rôle can be replaced by chemical or physical stimulus. But the other main rôle—the mingling of two inheritances—is something quite apart and more distinctively vital. Now it is interesting to find that the careful experiments made by Professor H. S. Jennings on conjugation in Paramoecium, the slipper-animalcule, all point to the conclusion that conjugation does not effect any rejuvenescence, its meaning being rather to secure biparental inheritance, which often means variation. When the conditions of life are untoward, conjugation is apt to occur, and it may be followed by new combinations of qualities, some of which are suited to the altered conditions of life. In those infusorians conjugation implies a loss of vigour, but it promotes variations some of which pay by securing survival.

XUM

REVIEWS.

ASTRONOMY.

Daytime and Evening Exercises in Astronomy.—By S. F. WHITING, Sc.D. 104 pages. 26 illustrations. 7½-in × 5-in.

(Ginn & Co. Price 3/6.)

This book is written for schools and colleges. The aim of the authoress is to encourage and direct the teaching of astronomy during the *daytime* (and night also) instead of waiting for night instruction only. The method proposed is to make practical acquaintance during the daytime with many objects and branches of astronomical work, by means of the study of models, globes, photographs, and other apparatus, as set out in forty-five exercises. She has certainly succeeded in putting a good deal of facts and questions into these hundred pages; but the book is primarily an aid to study and work, and should be useful to teachers. If the book is intended to be used here we think that, in another edition, the articles mentioned on pages xi–xiv should not be restricted solely to U.S.A. goods; but, as equally good apparatus and books are known and can be readily obtained in this country, we suggest that these be given as alternatives; many of the names now given are quite unknown here. We would further suggest some considerable reduction in the price. The Index is very meagre and of little use: we looked for six important items given in the book—four were not in the index.

F. A. B.

Annales de l'Observatoire Royal de Belgique.—Physique du Globe. Tome V., Fasc. III. 197–308 pages. 12½-in. × 9¾-in.

(Hayez, Bruxelles.)

This is a continuation of a long series of observations made at the Belgian National Observatory at Uccle. The present part contains the Hourly Magnetic Observations made at Uccle in 1911 and their discussion by A. Hermant, seventy pages and two plates; Observations of Atmospheric Electricity in 1910 and 1911 and their discussion by A. Hermant, twenty-five pages and four plates; and the Temperature of the Sun (*i.e.*, the Earth) at different depths in 1911. From this last section it may be seen that thermometers placed at depths of $0^m{\cdot}1$, $0^m{\cdot}2$, $0^m{\cdot}3$, $0^m{\cdot}6$, $1^m{\cdot}0$, $1^m{\cdot}25$ and $1^m{\cdot}50$ all record the (mean) maximum temperatures in August, that at one and a half metres being nearly the same in September; while the (mean) minimum temperatures occur in January for the first four depths, at one yard the retardation or greater deviation from the external air temperature becomes pronounced, and the (mean) minimum is not reached until the month of February; the mean temperatures at all these depths in March and September are very similar: the range is within half and one degree (centigrade) respectively. But we think the means for such periods as thirty days are much too long and mask interesting facts.

F. A. B.

L'Astronomie: Observations, Théorie et Vulgarisation Générale.—Par M. MOYE. 396 pages. 4 plates. 43 figures. 7½-in. × 5-in.

(Paris: O. Doin et Fils. Price 5 francs.)

This is one of an extensive series called "Encyclopédie Scientifique," published under the direction of Dr. Toulouse, Directeur de Laboratoire à l'École des Hautes-Études. There is a short account or preface of six pages on the "Bibliothèque d'Astronomie et Physique Céleste," by J. Mascart (Director of the Lyons Observatory, who is to be the astronomical editor of the series), in which there is a discussion of the influence of various other sciences upon astronomical knowledge, the reasons given for these books, and the lines upon which they will be written. It is intended to publish twenty-nine volumes upon astronomical subjects, of which this volume by M. Moye is No. 1; there are three others already published. The series is therefore a composite one so far as concerns authorship, and it is intended that each volume shall contain about three hundred and fifty to four hundred pages, with illustrations, in cloth, and be sold separately at five francs.

The spirit in which the book is written may be given in the editor's own words:—"Une notion prévaut pourtant le caractère mystique, ardu et rébartif, de la science astronomique, science réservée aux plus savants des savants et dont la moindre teinture semble donner à ses adeptes figure de profonds techniciens. Au risque de perdre notre auréole, nous avons au contraire essayé de démontrer la facilité avec laquelle on peut mettre l'astronomie à la portée de tous ceux qui veulent en apprécier les philosophiques jouissances."

The book is not a text book or handbook replete with references, authorities, quotations, formulae, calculations, or tables of figures; nor is it quite of the scrappy popular form, with speculations frequently bubbling out, appealing to the senses. It takes its place as an introductory book to general astronomy, and is just suited to young folks at high schools, in their Continental sense; for a university course it is too popular and elementary. Most of the very numerous features and facts in astronomy are referred to in a pleasant reading and concise form. The type and figures are not too fine, a frequent fault in French books; the paper is poor. We still notice the persistence of the use of French words for the constellations. When will the French astronomers come into line with the rest of the world and use the Latin designation? At the end there is a useful list of books consulted; also an index, which is very poor and incomplete. On page 277 the author erroneously attributes the discovery of the crape-ring to Bond and Dawes, and not to Galle; and the date given, 1858, should be 1850. Galle's observation of the crape-ring was made and published in 1838.

F. A. B.

CHEMISTRY.

Gas Analysis.—By DR. HARTWIG FRANZEN. Translated from the German by F. CALLAN, M.Sc., Ph.D. 120 pages. 30 illustrations. 7¼-in. × 4¾-in.

(Blackie & Son. Price 2/6 net.)

This little book should be found of great use as an introduction to the larger works on gas analysis. Little knowledge of the subject is assumed, and the directions for using all the more simple forms of apparatus are sufficiently full and clear for any beginner to follow, while excellent diagrams are provided where necessary. The book is divided into two sections, the first of which gives the methods of analysing the common gases, while the second contains some of the principal applications of gas analysis in the examination of inorganic substances. By the way, the title of this section—"Volumetric Gas Analysis"—is somewhat misleading. Tables of the chief physical data required in gas analysis are appended, but it is a drawback to an otherwise excellent book that no index is given, and that the reader has to search through the list of exercises for what he requires.

C. A. M.

Qualitative Determination of Organic Compounds.—By J. W. SHEPHERD, B.Sc. (Lond.). 348 pages. 20 illustrations. 7-in. × 5-in.

(W. B. Clive. Price 6/6.)

A successful attempt is made in this book to systematise the analysis of organic compounds upon similar lines to those followed in the examination of inorganic substances. The arrangement is distinctly novel and gives a clearer view of the principles underlying organic analysis than any other book with which we are acquainted. The first part deals with the characteristic reäctions of the different groups of organic compounds, while in the second part the reäctions are classified and illustrated by typical examples drawn from the different groups. The class to which a given substance belongs having been discovered by systematic tests, the substance may then be identified by its physical properties, and for this purpose a good tabular index is provided.

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Enough has been said to show the value of the book, not only as an aid to examination, but also as a practical guide to the student of organic chemistry. It is of necessity concise, but it suffers in places from too much condensation, and this is particularly noticeable in the section on Enzymes. In this connection we notice that the author alludes to the coagulation of blood as a fermentative process—an hypothesis which lacks confirmation. The book would gain much if a section were added on the qualitative analyses of dyestuffs upon the same lines as those devised for the substances dealt with in the other sections.

C. A. M.

The Atmosphere.—By A. J. BERRY, M.A. (Cambridge Manuals of Science and Literature.)

146 pages. 5 illustrations. 6¾-in. × 5-in.

(The Cambridge University Press. Price 1/- net.)

The first impression after reading this little book is a feeling of wonder how so excellent an account of the scientific investigation of the atmosphere can be produced at so low a price. The subject is treated purely from the chemical and physical standpoint, and omits nothing of importance from the days of Galileo to the present time. Separate chapters are given to liquid air, radioactivity, the inert gases, and so on, and there is a most interesting outline of the views and speculations upon the probable composition of the atmosphere in prehistoric times. Every page of the book is readable, and all points in dispute are stated fairly and without bias. Portraits of Boyle, Priestley, and other early chemists add to the interest, and there is a good bibliography and index. In short, this is a model of what a popular scientific book should be.

C. A. M.

One Hundred Simple and Exact Mathematical Proofs that the Valencies of Carbon are Unequal.—By HAWKSWORK COLLINS, B.A. (Cantab.). 110 pages. 8¼-in. × 5½-in.

(Morton & Burt. Price 7/6 net.)

This volume is a sequel to the author's "The Relative Volumes of the Atoms of Carbon, Hydrogen, and Oxygen when in Combination," reviewed in "KNOWLEDGE" for January, 1912. In it Mr. Collins shows how his method of calculating molecular volumes may be extended to bodies containing the halogen elements. So far as the results go the atomic volumes of chlorine, bromine, and iodine in combination with carbon are constant, being 23·01, 27, and 32·75 respectively, whilst carbon, hydrogen, and oxygen have the same values as before. The calculated values are in extraordinarily good agreement with the experimental results of various investigators, as was also the case in the former volume. In view of this fact it is difficult to understand why Mr. Collins's calculations do not receive greater attention from physical chemists. His books are certainly worthy of this, whatever views may be held concerning his theory of valency. As I mentioned in the former review, Mr. Collins explains the fact that hydrogen may have, according to the configuration of the molecule, any one of four different values, by the theory that the valencies of carbon are unequal. No doubt this would explain it; but more than one alternative hypothesis is possible; and so this peculiarity in the calculated atomic volume of hydrogen cannot be regarded as proving the inequality of the carbon valencies. Further calculations dealing with the molecular volumes of compounds containing other elements are promised by Mr. Collins, and will no doubt be awaited with interest by those who can value calculations of this sort, and can appreciate the labour involved in making them.

H. S. REDGROVE.

ECONOMICS.

The Economics of Everyday Life.—A First Book of Economic Study. By T. H. PENSON, M.A. Part I. 176 pages. 48 tables and diagrams. 7¾-in. × 5¼-in.

(The Cambridge University Press. Price 3/- net.)

This work forms an admirable introduction to the science of economics, and should meet the requirements of both the general reader and the student who is just commencing a study of the subject. The author's language is clear and simple; he is careful to give accurate and precise definitions to the terms he employs ("wealth" and "labour" may be noted as particular instances); and the frequent use of diagrams aids greatly in enforcing the meaning of the text. Part I of the work is divided into four books, dealing respectively with introductory matters, production, exchange, and distribution. Part II will deal with consumption, taxation, and trade unions and coöperative societies.

A few points call for criticism. Mr. Penson explains the construction of demand and supply curves, but he omits to point out that if both curves are drawn to the same axes, the market price of the commodity dealt with (under the simple conditions considered) is given at the point where the curves intersect: this would probably not be obvious to readers unacquainted with graphic algebra. In dealing with the division of labour Mr. Penson notes both the advantages and the disadvantages, but, whilst insisting on the former, unduly depreciates the latter. Up to a certain point (*i.e.*, into trades and professions) the advantages are immense and the disadvantages very slight. But when division is carried to the extent of incomplete processes, the gain to the community (or, rather, to certain members of it) is, I suggest, outweighed by the loss to those who are engaged in carrying out such incomplete processes. It is thus that the factory system arises with its many evils, especially the non-ownership by the workmen of the tools of his trade, which largely destroys his liberty and tends to make him the slave of the capitalist. Moreover, the happiness of a community depends, not only upon its wealth (*i.e.*, upon what it possesses), but upon what it does; and it cannot be denied that the carrying-out of incomplete processes is soul-destroying work, though such considerations, perhaps, belong to ethics rather than economics.

In enumerating the advantages of the large retail store over the small business Mr. Penson says that "the large scale tends to the accumulation of large amounts of capital in few hands, and thus to the amassing of large fortunes" (page 77). I cannot in the least understand in what sense this can be held to be a genuine "advantage."

In concluding the volume Mr. Penson writes: "Whether or not the existing system of distribution satisfies the claims of justice or achieves the best social results is quite outside the scope of the present work. In dealing with this question as with others the aim has been to point out and to explain things of everyday occurrence, to illustrate and to arouse interest in the economics of everyday life." That, of course, is the right attitude to take in an introductory work, in which economics must be treated as a natural, and not as a normative, science. Normative economics must come afterwards; but from the first, I think, we must be impressed with the fact that, whilst the skill and ability of the workman or organiser are inseparable from the man himself, capital *is* separable from the capitalist; hence that, whilst the workman and the organiser are of value to the community, and should be remunerated for their services, the capitalist is not only useless, but acts as a clog on the free flow of money.

H. S. REDGROVE.

ETHICS.

The Faith of all Sensible People.—By DAVID ALEC WILSON. 124 pages. 6½-in. × 4-in.

(Methuen & Co. Price 2/6 net.)

The title of this book, and the claim made for it that the title is justified, strike one as somewhat pretentious, and the author's style savours of dogmatism. But the book contains a good many sound common-sense maxims on a variety of topics, which show the predominant influence of Confucius. The writer believes in evolution, but rejects the theory of natural selection as unproven, though he offers no alternative thereto. In passing, I might note that the acceptance of natural selection as a scientific law by no means involves the acceptance of the materialistic metaphysics which frequently go along with it. Mr. Wilson has a keen dislike of transcendental metaphysics, and he asserts that we do and can know nothing of a life after death, if such there be. This, of course,

is sheer dogmatism. Experimental psychology has not yet said the last word on the subject, nor is it scientific to reject, without examination, the testimony of the religious consciousness. When, however, Mr. Wilson discourses on the value of knowledge, of perseverance and hard work, and on the advantages of the married state, most readers will agree with him. He explains that his object in writing the book was "to distil knowledge from current speculation" and to "show to the man in the street in plain words that the materialism so widely believed is not science but pseudo-science." But though I can fully sympathise with this object, I do not think it has been accomplished in "The Faith of all Sensible People."

H. S. REDGROVE.

MATHEMATICS.

The Nature of Mathematics.—By P. E. B. JOURDAIN, M.A. 92 pages. 6¾-in.×4¼-in.

(T. C. & E. C. Jack. Price 6d. net.)

This is a volume in the series entitled "The People's Books." Mr. Jourdain does well to indicate the practical value of mathematics and in emphasising the importance as concerns the history of mathematics of Mach's view that "science is dominated by the principle of the economy of thought." But from the standpoint of the general reader the book cannot be regarded as satisfactory. In the first place there are no diagrams to assist him in understanding the text. Moreover, the explanations, notably in the case of logarithms and "imaginary" quantities, are wholly inadequate to his needs. Dealing with the latter subject, the author says, "If we are given the equation $x^2-1=0$, its solutions are evidently $x=+1$, or $x=-1$, for the square roots of $+1$ are $+1$ and -1." He has not explained the multiplication of negative quantities, and so to the non-mathematical reader the "evidently" will come as a surprise. There is much else in the book of a similar nature. Of course, in so small a compass it is impossible to deal with the vast subject of mathematics adequately, but I think much of the space filled with talk about the "logical basis of mathematics" might have been better occupied with something about modern non-Euclidean geometry, and, if possible, vector-analysis as well. Mr. Jourdain distinguishes between mathematics and our knowledge of mathematics, and I gather that when he speaks of mathematics as having a purely logical basis he is denying that it is an empirical science. Mathematics, no doubt, makes larger use of deduction than any other science, but like all other sciences it is inductive at the basis. It is experience, not logic, that enables us to assert that $1+1=2$.

H. S. REDGROVE.

The "Method" of Archimedes, recently discovered by Heiberg. (A Supplement to "The Works of Archimedes," 1897.) Edited by Sir THOMAS L. HEATH, K.C.B., Sc.D., F.R.S. 51 pages. 15 figures. 8½-in.×5½-in.

(The Cambridge University Press. Price, 2/6 net.)

Heiberg's most valuable find is of the greatest value to those who are interested in the history of mathematics; that portion of it consisting of a work hitherto supposed to have been irretrievably lost is here presented in a convenient English dress and in modernised terminology. The Greek geometers, in their formal treatises, present the subject matter in a purely logical form, giving no hints as to the methods they employed in making their discoveries. The "Method" of the great Archimedes is, however, not a formal treatise, but a letter to a student; and in it he lays bare the manner in which he discovered a number of propositions concerning the areas, volumes, and centres of gravity of certain figures. The two chief propositions concern the volumes of two solids with one or more curved surfaces, which can be expressed exactly in terms of rectilinear solids. The method of discovery is a peculiarly interesting and ingenious one, making use of the mechanical concepts of moments and equilibrium, for which reason Archimedes did not regard it as supplying rigid proofs of the propositions discovered by its aid. He therefore supplied what he regarded as sufficiently rigid proofs of the propositions, partly here and partly in other works, though nowadays the mechanical proofs would be quite rightly regarded as sufficiently rigid. It is interesting to note that, in one case at least (namely, in the mensuration of the sphere), the order of discovery is not that of logical development; a fact which may very well be advanced against the once common idea that the best order of presentation in the teaching of geometry is the logical one. Students of the history of mathematics are under a large debt of gratitude to Sir Thomas Heath for this most valuable translation.

H. S. REDGROVE.

ORNITHOLOGY.

British Birds' Nests: How, where and when to find and identify them.—By RICHARD KEARTON, F.Z.S., F.R.P.S. 518 pages. With many plates and illustrations. 9¼-in.×6-in.

(Cassell & Co. Price 14/- net.)

Mr. Kearton's book is really a new edition of his "British Birds' Nests," with the addition of the best pictures that were published in another of his volumes, entitled, "Our Rarer British Breeding Birds," with others which have been more recently secured. A feature of the present book is the arrangement by which it is easy to find particulars of the nesting sites and materials as well as the eggs of many of our British Birds. The coloured plates of the Lapwing's nest and eggs, as well as that of the Tree Pipit's nest, are exceedingly good; and the figures of eggs reproduced by the three-colour process from actual specimens adds greatly to the usefulness of the work. It is evident that many photographs of the birds, especially those of the more timid ones, such as the Water Rail, must have been a great trouble to secure; and among the interesting points incidentally mentioned is one concerning Rooks which built on chimney-pots. As a book of pictorial records Mr. Kearton's "British Birds' Nests" is most charming, and as a book of reference is of considerable merit.

G. K. W.

PSYCHOLOGY.

Psychology.—By HENRY J. WATT, M.A., Ph.D., D.Phil. 90 pages. 8 figures. 6½-in.×4¼-in.

(T. C. & E. C. Jack. Price 6d. net.)

This is a volume in the series entitled "The People's Books." It is an interesting little introduction to the study of psychology, written upon somewhat different lines from that of most elementary text books on the subject, being less formal and schematic. Its condensed style, free use of technical terms (the meanings of which are not always explained), and the emphasis put upon the as-yet-unsolved problems of psychology cannot do otherwise than make it a somewhat "difficult" book for the general reader.

In dealing with the question of the empirical distinction between sensation and imagery, Dr. Watt points out that the mere degree of intensity does not supply an adequate basis of distinction. He adds: "The distinction of sensation and imagery must therefore depend upon our ability to say whether an experience has come about through impression from a real object or not. This is often expressed by saying that in dreams we take our imaginations for reality, because we have no reality by us to compare with them." This begs the question at issue; for what this question asks is: How can we distinguish between reality and imagination, or, rather (so as not to perpetuate the common misuse of the term "reality"), how can we distinguish objective from subject reality? I think that Berkeley adequately answered this question to the effect that sensations occur in definite orders and series ("laws of nature") lying without the control of our will, whereas imagery occurs, to a large extent, in what order we please.

There is a short but telling criticism of the Lange-James theory of the emotions in the book, and Dr. Watt well concludes by insisting on "that magnificent jewel that delights the eyes of all men and never wearies—the reality of effort."

H. S. REDGROVE.

XUM

ZOÖLOGY.

A Bibliography of the Tunicata, 1469–1910.—By JOHN HOPKINSON, F.L.S. 288 pages. 9-in.×5½-in.

(Dulau & Co. Price 15/- net.)

When Mr. John Hopkinson was preparing for publication Alder & Hancock's "British Tunicata" he compiled a bibliography for his own use, bringing matters up to the year 1870, and later, after consultation with Canon Norman, he decided to extend it to the year 1910. This has now been printed and forms one of the volumes published by the Ray Society for the year 1912. The care with which Mr. Hopkinson works is well known, and though he has been assailed with various difficulties he has produced a volume which will be of very great assistance to students of the Tunicata, while he has made up for any little deficiencies due to the printing of the work in two parts by appending an addenda of twenty-five pages.

W. M. W.

The British Parasitic Copepoda.—By THOMAS SCOTT, LL.D., F.R.S., and ANDREW SCOTT, A.L.S. Volume I. Copepoda Parasitic on Fishes. 256 pages. 2 plates. 9-in.×5½-in.

(Dulau & Co. Price 15/- net.)

This, the second of the volumes published by the Ray Society to subscribers for the year 1912, consists of the text of Messrs. Scott's work, with two plates. The bulk of the plates will appear as a volume for 1913. The Ray Society published in the years 1878–1880 a monograph of the British Free and Semi-parasitic Copepoda, by Dr. G. S. Brady, and from this those forms which were truly parasitic on fish were expressly omitted. Dr. Brady suggested that they should be dealt with in a separate volume, and Messrs. Scott have now produced it. With very few exceptions recent specimens have been examined and carefully dissected. The result is a series of very careful descriptions, to which are added details of the habitats.

W. M. W.

NOTICES.

THE ROYAL INSTITUTION.—A General Meeting of the members of the Royal Institution was held on the afternoon of June 2nd, the Duke of Northumberland, President, in the chair. Mr. L. R. Guthrie, Mr. G. W. Heath, and Mr. R. Malcolm, were elected members. The Chairman reported the death of the Right Hon. Lord Avebury, a member of the Institution for sixty-four years, and a resolution of condolence was passed.

SECOND-HAND PHYSICAL APPARATUS.—Messrs. Newton & Company announce that owing to the great development of their optical business they can find neither time nor space for their Philosophical and Physical Apparatus Department, and are therefore disposing of the whole of their stock at a low valuation. A catalogue has been issued, including demonstration apparatus in Electricity, Chemistry, Pneumatics, Sound, and so on.

ADDITIONS TO THE ZOÖLOGICAL SOCIETY'S MENAGERIE.—The number of additions to the Zoölogical Society's menagerie during the month of May was two hundred and sixty-eight, and among those which are new to the collection are two White-bearded Gnus (*Connochaetes albojubatus*) received in exchange, two Naked-tailed Mice (*Uromys bruijnii*) from Dutch New Guiana, presented by Mr. A. F. R. Wollaston, and a Chestnut-faced Barn Owl (*Strix castanops*) from Tasmania, which was purchased.

THE EAST COAST.—The east coast affords an opportunity for good work in Natural History and Archaeology, and we recommend to those who are thinking of spending their holidays there, a little book entitled "On the East Coast," by Percy Lindley, fully illustrated in half-tone and colour, which has just been issued by the Great Eastern Railway Company, and can be obtained gratis from the Superintendent of the Line.

BOOKS ON BIRDS.—Ornithologists will be interested in a catalogue which Messrs. John Wheldon & Company have just issued containing more than fifteen hundred titles. Besides general works dealing with the subject under geographical headings, sections are devoted to migration, to game and domestic birds, as well as to bird protection. No less than eighteen editions of "The Natural History of Selborne," by Gilbert White, are included under "Selborniana," with other works relating to the great field naturalist.

A NEW CAMERA.—We have received an intimation that in anticipation of the holiday season, to which the taking of photographs adds a great charm, the Optical Works of Messrs. Goerz are introducing a new "Tenax" camera. The working of this is simplicity itself, and it has an accurately graded shutter as well as all the movements required. Added to this it is fitted with one of the world-famous Goerz lenses, and the scientific worker who wants a camera will feel quite happy in taking advantage of what has been done for his lay brethren.

ENGLISH MICROSCOPES.—We have pleasure in calling attention to Messrs. James Swift & Sons' catalogue of Microscopes and Accessories. In runs into seventy pages and contains figures and descriptions of the more important of the well-known microscopes which this firm produces. There are some pieces of apparatus of particular use in certain cases that may be mentioned, such as the Stevenson Binocular Microscope for delicate dissection; the simple cone camera for attachment to the draw tube of the microscope, and the stereoscopic photomicrographic attachment designed by Professor Herbert Jackson, which gives perfect stereoscopic photographs of suitable subjects under the microscope.

MACMILLAN'S NEW BOOKS.—The catalogue of new books which has just been issued by Messrs. Macmillan contains among the notes, some details of the life of Miss Octavia Hill, and in the classified list of books recently issued we notice several on Archaeology and Agriculture. Mayo's "Diseases of Animals" has been increased in price from 6s. 6d. net to 8s. 6d. net, and "Franklin's Electric Lightning" from 10s. 6d. to 12s. 6d. Volume XC of *Nature*, September, 1912–February, 1913, is now ready, price 15s. net.

NESTING BOXES.—The great benefits which many birds confer on the agriculturist and the forester have long been appreciated in foreign countries, and recently it was pointed out in the press how the Thirlmere plantations had been saved from the attacks of the larch saw-fly owing to the provision of nesting sites by the Manchester Corporation. In this connection it is interesting to chronicle that the Royal Agricultural Society has specially invited the Selborne Society to send a representative series of its very successful nesting boxes to the Forestry Exhibition, which will be held in connection with the Royal Show at Bristol from July 1st to the 5th.

THE EMU.—Messrs. Witherby & Co. have been appointed European Agents for *The Emu*, the organ of the Royal Australasian Ornithologists' Union, and copies of that publication can now be obtained at 326, High Holborn.

THE NATIONAL PHYSICAL LABORATORY.—The Annual Meeting of the General Board of the National Physical Laboratory was held recently at the rooms of the Royal Society, when the report and accounts for the year 1912 and the statement of work for 1913 were presented and approved for transmission to the President and Council of the Royal Society.